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THE ROLE OF PURE SCIENCE[1]

By Dr. RALPH W. GERARD

ASSOCIATE PROFESSOR OF PHYSIOLOGY, UNIVERSITY OF CHICAGO

ONE anecdote has it that, when Gladstone, shown the electromagnetic motor, asked, "What good is it?" Faraday replied, "What good is a baby?" The same question might be asked about science itself, the last great offspring of civilization, sired by intelligence. If no longer a baby, it is at least an obstreperous child, already playing mischievous pranks on its staid mother, and fearsomely regarded by many as irrevocably headed towards a wayward youth and a criminal maturity. Some babies are best unborn; is this such a one? Science, we hear, has warmed our homes but not our hearts, increased our longevity but not our charity, raised our speed but not our hopes, brightened our nights but not our spirit; in short, that it has comforted our flesh but destroyed our soul. Society is sick and science must be poisoning it, for it has been taking great mouthfuls of the bitter stuff; and is it not always something just eaten that is responsible for any ache?

As a physician, I know that a generous portion of peppermint, applied outside or in, neither brings on nor wards off a renal colic; and as a scientist I demand better evidence than "post hoc ergo propter hoc," before agreeing that the social organism is suffering from scientific dyspepsia. But let us clearly understand one another before proceeding.

"Science," as Conklin, retiring president of the American Association for the Advancement of Science, said last week, "is organized knowledge, and knowledge itself is neither good nor bad but only true or false." Pure science is concerned only with understanding, not with using; it might be denounced as valueless, never as harmful. But, comes the cry, this is sophistry; for are not scientists incessantly prating their wares and

[1] An address presented before the American Institute at a symposium on "Some Social Implications of Inventions."

asking society to buy of them; do they not ask to have their researches subsidized and promise a manifold return on the investment; is there any demarcation between pure science and applied technology, which most assuredly does use knowledge for weal or woe. Let me answer in reverse sequence.

Pure science is not distinguished from applied by method, which is identical for both; often not by content, which may overlap in each; but by intent alone. The technologist endeavors to solve a problem with a view to immediate utilization—whether for individual or general ends; the scientist, only to know the solution. His immediate gain is the selfish satisfaction of the climber struggling to the summit, of the poet rounding his rhyme or, if you will, of the successful cross-word puzzler. Hill, a Nobel laureate, has put it well.

> In scientific research we work and work, sometimes for months and years, in digging a tunnel with no apparent results; then suddenly comes the supreme joy of life—daylight begins to glimmer at the end, and in a few minutes we see that nature, after all, has not played us false. To one who works honestly and accurately, these moments are sure to come.
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> It is no use, therefore, to tell a scientist that romance is dead, or a physiologist that physiologic problems are insoluble; the emotions he has experienced in finding new worlds will effectively prevent him from believing you. No joy can be greater than to find convincing evidence for one's faith that nature is ultimately reasonable, no emotion more satisfying than to achieve exact and quantitative verification after months of trial and experiment. Do not think, therefore, that the new laboratories here are peopled with patient drudges, moved perhaps by intelligence but never by emotion. There may be as much real poetry, as much real magic, as much real romance, within these walls as a human life can hold.

Or, again, there is the story of the three hod carriers. On being asked, "What are you doing?" the first replied, "Carrying bricks"; the second, "Earning a dollar an hour"; the third, "Building a cathedral." The last represents pure science.

True, few scientists would justify their labors on such a basis, even to themselves, let alone to society. That may be the reason they wish to do research, not the one that makes them think they should do it, and be aided in the doing. There is, besides, the conviction that the fruits of discovery will benefit all mankind—not at once but soon or late, and riper and more luscious for the waiting. They point out to themselves and the world, correctly, case upon case of the "purest" scientific advances that have risen rocket-like into the intellectual sky only to burst and scatter mankind with riches; induced electricity and the motor, electrons and radio or what you will, hormones and the relief of disease, structural formulae and modern creative chemistry. But, then, pure science is simply long-range application; and motors and radios do make noise, and chemistry creates explosives and tough steel from which to shoot them, and science is daubed with the same paint as technology.

From my view-point, science has another far more valuable contribution to make to mankind than that of upholstering his physical comfort; a vital contribution to his mental climate. And this is at least tacitly recognized by modern educators who include ever more scientific subjects in the curricula. Surely none is so fatuous as to believe that a few semesters of dabbling in physics, chemistry and biology at the high school or college level will prepare the student to build or even repair their autos and radios, let alone to improve upon them. It takes no great erudition to be a handy man about the house, and radio repair men do quite well without having heard of the Schott effect or the uncertainty principle. In biology, where the gulf between common experience and the more esoteric expert knowledge has not yet opened so widely, some practical returns may result from even a casual acquaintance with the latter. It may be useful to know, for example, that spinach is not especially rich in iron, that cathartics do more harm than good, that yeast has no magic dietary virtues, and that patent medicines are, almost without exception, expensive packages of common chemicals and more often harmful than efficacious. But we don't ask the precious hours of youth just to warn them to polish the arsenic spray from their apples before eating them.

Education has two major aspects: utilitarian, vocational training to enable one to live effectively in society, to do; and esthetic, avocational training to enable one to live with himself, to be. The former includes the pre-school shaping into the major molds of civilized behavior, with the aid of the few "do's" and the many "don'ts"; the use of language and number taught in elementary school; and such technical information and skill as are acquired in appropriate trade or professional schools. It is reasonably tangible, and on the whole this education achieves its goal. The esthetic education—the word is not satisfactory for it should embrace more; yet I would prefer it to ethical and so emphasize beauty over good; better is the Greek, Kalos, which includes the good, the true and the beautiful—the esthetic education is the general education which President Hutchins, of the University of Chicago, has recently expounded. It is the appropriate nucleus of high school and college, although not university, training; the very portion of the curriculum which is being enriched with science courses.

This phase of education is confused because its ends are so intangible and the progress towards them so difficult to evaluate. But it is incomparably more important than vocational training, for it shapes the man

and so eventually the society. I hasten to add that esthetic education is not purveyed only in college classrooms at so much a course—it is acquired by steady accretion from family and other social groups. But any formal inculcation of its elements is concentrated at this level, and only by this means can conscious and deliberate direction be given. What, then, should this training for self include?

I submit that it must deal with values and with judgment, must help to establish individual standards and to display materials of worth. Let me be more specific. An ear tuned solely to such strident rhythms as "Yankee Doodle" will not at once respond to Beethoven's softer cadences, melodic though they be; nor will the magnificent panorama of celestial and animate evolution have any appeal to the intelligence that has never soared from a bookkeeper's desk. Certain intellectual and emotional events have value to persons able to appreciate them, and bring additional pleasure and richness into their lives. Man is the highest animal only in the sense that he has the possibility of a greater variety of experience than have others, and the "higher" type of man can savor adventures of the spirit to which the lesser one is insensate. In this sense, then, one may speak of establishing standards of and a taste for the worthy and good—a task of esthetic education.

Besides implanting an urge for the good, the true and the beautiful, this phase of education should offer examples of them and, even more, acquaint the student with their sources in library, laboratory and museum, and encourage him to explore them. Facts and ideas, no less than poems and pictures, may have their beauty. I shall never forget the state of exaltation in which I left the chemistry lecture room after hearing, in the even slightly monotonous voice of Julius Stieglitz, the story of the brilliant logic and inspired experimentation with which Emil Fischer built and identified the unknown but theoretically anticipated kinds of sugar molecules. To one without the requisite background, the lecture would be a tedious mistake. The painter finds much in a picture overlooked by others, the chess-player alone can rhapsodize over a scholarly mate, the scientist can see in the starry sky or the human body beauties invisible even to the lover's eyes. Science, like art, contains the beautiful and offers ever more riches to him who penetrates its terrain from the frontier of dilettante interest to the hinterland of research advance.

The avocational part of education must include, besides the esthetic, still other elements which are of no less importance to the individual and of the gravest import to society. These have to do with truth and judgment, are primarily at the intellectual level, and are quite particularly related to science. To the extent that man acts rationally, he makes progress in the battle with chaos, and he and his society become more integrated and more complex. Irrational behavior, directed by emotion when intelligence is uninformed or in abeyance, is sooner or later retrogressive. This dichotomy of intelligence and emotion, as we shall see later, is rooted in very well-known brain mechanisms.

What are some earmarks of intelligent behavior? First, the absence of superstition, the emancipation from fear of nature and the here-and-now prejudices of the group. I doubt if we of this century and culture can remotely glimpse the load of fear and darkness that oppressed less enlightened souls. Think of the aboriginal gods—lurking in animals and trees, in earth, winds and waters; cruel, demanding, all-powerful; quick to destroy, difficult to propitiate; rendering the future insecure and the present restricted—that peopled the primitive imagination. Recall the native, taught by missionaries to plow deep, who, alone in his tribe, grew grain despite a drought and whose torn-off limbs were scattered on the field to repel the Evil One. Think of our own recent history—the heretics tortured, the were-wolves burned and witches drowned, the sick exorcised; largely in good faith. The Koran was only recently printed in Islam, for it was blasphemy to touch the word "Allah" with pig bristles. Think even of the shrouded nether-limbs of a past generation and the stilted forms of ordinary communication. Our present intellectual climate leaves much to be desired. Heaven knows we do not yet walk in the light of clear day, yet we can look back at the pea-soup fogs of the past with some sense of progress. This I credit to science.

Second, intelligent behavior is marked by tolerance. The new is neither fatuously accepted nor blindly damned. Decisions are reached after due instruction in and evaluation of the facts, pro and con; and action, while not always correct, is rational in the light of the evidence and, since action generates new evidence, it is automatically self-corrective. Need I belabor the past on this point, too, and recall to you the ignoring or persecution of nearly all great innovators of history? Possibly a single instance will be interesting. I quote from the "Report on Technological Trends and National Policy": "In Germany, it was proven by experts that if trains went at the frightful speed of 15 miles an hour on the proposed Rothschild railroads, blood would spurt from the travelers' noses, mouths, and ears, and also that the passengers would suffocate going through tunnels." This, of course, is a mild example and seemingly based on facts and reason, yet a real effort to evaluate, as quantitatively as possible, is conspicuously lacking. As Boake Carter has said, Everyman is the worst censor. Let a radio speaker discuss a live issue, and proponents of one or

both sides flood the sponsor with threats. I contrast the attitude of William Jennings Bryan, who said to an eminent botanist, "I know nothing of evolution but hate it with my whole heart," with that of Thomas Huxley, shown in his famous invocation, "God, give me the courage to face a fact though it slay me." Intellectual honesty is the motif of science.

Third, intelligent behavior does not confuse the symbol with the thing. This requires some explanation. Man tries to understand nature, for his pleasure and profit. But nature is a blooming buzzing confusion of semi-discrete units and systems in a great continuity. Analysis can not proceed until this is ordered into classes—for logic and science deal with the constancies of the category and not with the uniquenesses of the individual. This organization and attendant distortion of "reality" (and let us not enter the metaphysical problem as to whether a real universe exists) is carried out in part by the physiological processes of sensing, in part by the psychological ones of reasoning. Only after grouping individuals into classes can logic proceed, yet any such classification violates the individuality of the members of the class. "Nature," as Whitehead says, "doesn't come as clean as you can think it." Yet, "thought is abstract and," he continues, "the intolerant use of abstractions, is the major vice of the intellect." Words, themselves, are classes and stand only as symbols for something else, symbols which are imperfect and shifting representations of that for which they stand. Their meanings change— as, for example, in the adage, "The exception proves the rule"; "proves" to-day has the meaning "demonstrates," although originally (and with greater wisdom) it stood for "tests" and is still so used in "proving ground." "Facts" also are abstractions and, like words, may lead via the machinery of the most impeccable logic to bizarre conclusions. Even philosophers have fallen into the "error of misplaced concreteness"; most of mankind wallows in it. Label a man or an action bolshevist or fascist and he or it is damned; make the eagle scream out for Americanism and it, with all the lice that inhabit it, is welcomed into our homes. The antidote is science.

I have said that education for truth, for a rational behavior, engenders freedom from superstition and prejudice, inculcates tolerance and the open mind, and brings discrimination of the symbol from the symbolized. I credit science, pure science, with such progress as civilization has made in this direction and maintain that in its charge lies further advance. On what grounds is so much claimed for science? Conklin has summed the case up admirably, ". . . as an educational discipline there are no other studies (than science) that distinguish so sharply truth from error, evidence from opinion, reason for emotion; none that teach a greater reverence for truth nor inspire more laborious and persistent search for it. Great is philosophy, for it is the synthesis of all knowledge, but if it is true philosophy it must be built upon science, which is tested knowledge."

Science is tested and organized knowledge, gleaned and tried with the aid of its powerful method. Surely it is not necessary before this group to reiterate the character of this process—observation, explanation, experimentation and rejection, or, occasionally, confirmation. The elimination of chance by repetition, of extraneous factors by controls and of faulty conclusions by tests of their predictions are commonplaces to you. This habit of mind and action is indigenous in but not confined to the laboratory. It is the flowing river that deposits a rich alluvial delta of new-made wisdom. It is the greatest invention of man, the method of invention.

If our sacred cows of belief and convention can not stand the light of reason they are sickly animals. Do you maintain that science has undermined the foundations of ethics, I reply, "Only of false ethics." There is no conflict between the true and the good any more than between the true and the beautiful. Whichever idols have crumbled with the growth of science were made of clay, and it is well to have cleaned out the debris. Religion is struggling to establish new ethical values; surely science, which has faith in truth and honesty, in patience and order, strains at her side. Perhaps, even, the new ethics will stem from science directly.

On the other counts, tolerance and realism, the case for science, for its method, is unequivocal. Both depend on reason tempered by facts, on logic checked by empiricism at each extrapolation, on drawing honest conclusions. He who would navigate onwards into the unknown must steer on the star of truth with the compass of logic, but he dare not neglect to take frequent bearings with the sextant of observation. And this is the way of science. Pure science has these great contributions to make to society, through general education, a tried methodology and disciplined minds with which to attack its problems.

Many of you, I am certain, are now about at the bursting point of indignation with my elegiac mood. "Man, alive," you would say, "stop talking like an evangelical Pollyanna and look at some facts yourself. Science has been taught in increasing intensity for a century or two and you have already admitted that we still are clouded in prejudice, intolerant to an extreme degree, and regularly misled by words. And you can't wriggle out of it by saying that science has not adequately reached the masses, for we know any number of scientists who are as egregious asses as the rest of

us when they dare to emerge from their narrow specialties, which, by the way, they rarely do."

Yes, I know. Much that passes for science is utterly trivial and many of its supposed devotees are dull followers of a trade. Don't you, my friendly challenger, make another error and mistake the word for the thing. If you define "science" as the produce of departments of physics, geology, botany, etc., and "scientists" as the men who people them, we are not talking quite the same language. One must distinguish religion from creed, religious experience from formal worship, creative painters from rote copyists, brilliant explorers from the gleaners that trail them, intellectual calisthenics from a mental Turkish bath.

Yet I must admit there is something to your position. Scientists to-day fall far short, on the average, of what one might expect from them. It is, perhaps, possible to trace the reasons. A century and more ago, science was an esoteric pursuit. The men who followed its call were amateurs, usually wealthy or patronized. They worked largely as individuals at an avocation or hobby, like philatelists to-day, because they enjoyed it. They were eddies in the social stream, amusing or ludicrous to the serious-minded of the time but not important. One cultivated science as one cultivates a garden, without ulterior motive beyond the satisfaction of watching its lovely flowers unfold. Not so to-day. Science became useful, its flowers yielded expensive perfumes and healing drugs, and it was taken up by the best society. Departments of science crowded into and multiplied within universities, even high schools; research institutes sprang up; industry sprouted laboratories or subsidized technical schools and plants; great foundations pumped nourishment into all these, aided here and there by government. Technology spread everywhere, new industries based upon it grew into gigantic stature. And men were needed.

The little band of scholars quietly exploring intriguing corners of the unknown was lost in the surge of recruits. Science had become a respectable profession and, if not promising quite the financial success of the older ones, it had other desiderata, as security. Students rushed to grasp the new opportunities and were welcomed into the schools and later into the industries. Some became the teachers for later groups. The main orientation was utilitarian, the motives, economic, the caliber, small. Democracy triumphed and the intellectual aristocracy was dead.

But if this were the whole story, my case would be barren, indeed, with real science necessarily the prerogative of the elite alone. A more fundamental problem exists than the mere expansion of science due to social usefulness. This, in itself, is probably to be applauded; certainly there is no more cause for dismay than is offered by the existence of a medical profession. The trouble is with education as a whole. It is too much a Turkish bath.

I have described earlier what education should be and the pivotal position in it of the scientific attitude. But, although courses in chemistry and physiology flourish everywhere, few students are ever given a glimpse of science. They learn the facts, theories and techniques of a subject, yes, even how to plan and evaluate experiments, but they rarely are exposed to the true scientific spirit. How could they be when the men who teach them do not have it? Some years ago I heard a student who was just about to receive his Ph.D.—mind you, his degree as doctor of philosophy—tell in a seminar about the French "anatomist," Descartes. The name was obviously new to him, he pronounced all the consonants and misplaced one—Descrates. He is now teaching science to another generation.

There is a cycle in education which might be benign but is still vicious. Bad teachers teach students badly so that they in turn become bad teachers. Ignorance, like syphilis, would be eliminated if we could only make it spare one generation. What a stride forward humanity would take if just one crop of youngsters was put through the hands of really good teachers! This is just pleasant day-dreaming; we have not enough good teachers nor prompt means of developing them. Yet the situation is not hopeless, and civilization has always had to pull itself up by its bootstraps. Leaders do emerge, talent does exist, and barbaric hordes do become cultured. Real scientists and teachers are among us in considerable number, and when society is prepared to encourage and support them, and recruit to their ranks other men of ability, progress will be rapid; for, as I have shown elsewhere, the scientific spirit *can* be imparted to students.

There is one more point to make about teaching scientists and educators in general, especially in this country. Let me say it quickly and have it over, for it is rather shameful. The truth is that those in social and financial power—donors, governments, founders—have so little confidence in professors that they do not trust them to run themselves, let alone others. Almost without exception, a separate body—of trustees, president, deans and other administrative officers—runs our universities and the faculty pretty much does what it is told. Administration is often enough excellent, and academic freedom is jealously guarded in any university worthy of the name, but the fact remains that our institutions of higher learning are painfully different from a republic of scholars.

Is it any wonder, then, that science has made no greater impress on the mind of man and that scientists are so often found wanting? They have nearly all been taught badly, except in some limited field of proficiency; they have been debased by the rapid and in-

completely assimilated influx of opportunists; they are little prized, except for their technical skill; of course they are oblivious to or prejudiced about most problems of society. A man may do sound scientific research yet not exhibit generally the scientific attitude nor impart it to his students. But one who has not even this apprenticeship to truth is likely to do less well.

Let us return to our sick society, for something surely ails it, although I hope to have shown it is not pure science. What medicine does it need, and who should administer it? The treatment depends on the diagnosis, of which more shortly; the scientist has often been put forward as the physician. Now I suspect that a really first-class scientist may make a first-class statesman—was not the chemist, Eliot, one of Harvard's greatest presidents?—but I doubt if he would be more likely to be so than other first-raters. The scientist has on his shoulders even now, besides his chosen task of research, the duties of teacher and often philosopher (as well as citizen and individual), and that of administrator is not lightly to be assumed. Further the innovator is rarely the developer; not Trotsky but Stalin directs the destiny of Russia. No one man has genius enough to run a nation, and it seems wiser to have in charge a skilled politician who relies on expert scientific advice than to have a skilled engineer advised by expert politicians. The important thing is that the best knowledge, the best brains and the best will be drafted to the task. This is not easy of achievement; but more later.

Now, what ails society and puts the time out of joint? Is it technological advance as such or the discrepancy between this and static institutions or something else entirely? Two accusations are made against technology—it has made war horrible and peace ugly and impoverished. As to the former, gunpowder is only powerful—not good or bad. If used for ill, the fault is with the user. Poor old human nature must take the blame. And although it is true enough that it is better to keep powerful weapons from irresponsible hands, the only realistic solution here is to eliminate the irresponsible for, willy-nilly, technology will march on.

The influence of technology on our work-a-day society requires further comment. Ogburn, in the report of the committee already referred to, points out the sequence of changes following a new and important invention. First there is a lag (a third of a century or better) before it is accepted and applied; then comes its technical use and the attendant economic changes; later, often much later, there follows a modification in social institutions—home, church, government; and only at long last do the customs and beliefs of the populace fall in line. The spinning jenny is blamed for the industrial age. Yet it was merely a more efficient instrument for getting work done, just as the electric vacuum cleaner is more efficient than the broom. Have you ever heard the myriad household aids blamed for social dislocations—the electric washer and iron and mixer and cleaner and stove and razor and light? Oh, yes, we grumble about the lady of the house wasting her time on bridge and her money on beautification now that the galloping watts leave her skin soft and her hands potentially idle, but we love her all the more.

Had the new tools of industry likewise remained in the hands of the single worker in his house or shop man, like woman, would have been the gainer. But, of course, they were too large for the individual home and purse of the worker and note, please, for the purse of the inventor as well. So they passed into the hands of the entrepreneur and banker who, in full harmony with the current mores, exploited them to the limit for their personal gain. There resulted more goods and profit from less work, but the owner took the profit and the worker lost the work. Less skill was required, so women and children were hired instead of men and more cheaply. There followed in course the decay of the family and the rise of the slum. Later, much later, the social ethics stirred in its sleep and folk began to look askance at the robber barons of a new age of feudalism.

So far you must all agree, these evils following invention (the accelerated tempo of life in general is a separate question) did not flow from the technical discovery but from its befuddlement with property rights which took precedence over human rights. To-day the mass of the people repudiate such standards and many nations have expressed a collective discontent by plunging into great social ventures and new -isms. The world is groping in many directions for new air and light; all sorts of expedients are being tried, blunderingly; but the spirit of change is marching and can not be stopped.

I should be a poor scientist indeed, with my lack of knowledge and experience, to presume to know the proper answer. The diagnosis, I think, is fairly clear, but the disease is unfamiliar and the therapy to be worked out. But this much I must say, as a scientist. Here is an empirical problem requiring rational solution more urgently than any in human history—and the scientific method is the one best proven instrument for solving it. Even this may not succeed, but then no other attack will either and humanity will grind itself into decline.

It may be worth a final few minutes to examine more closely the possibilities. One of the most significant of technological advances is that of communication. The talking movie and the radio at present, to be supple-

mented at any moment by television and the home printed news sheet, afford amazing means for influencing the collective mind. Entering the home, reaching the child, they carry terrific power for leading the intelligence on by education or debasing it by propaganda. And remember human beliefs are social facts; for man's acts depend (in part) on what he thinks is true, aside from its objective truth or falsity. It will not do any longer to cleave to a laissez-faire principle, for it is being flagrantly violated. Once a dictator captures the people's mind by censoring the unpleasant and broadcasting the spurious they are indeed his slaves, for even reason is powerless with faulty materials. Something must be done, now, to secure for the ends of proper education these channels of influence.

But who shall control communication and make the all-important decisions as to what constitutes proper education? Is not human nature such that any man or any group wielding this enormous power will drift into selfish tyranny? Perhaps so; but this is certain, that there will be least abuse at the hands of men conditioned to intellectual honesty, tolerant judgment and respect for truth.

At least it would be a simple matter even yet to keep the control of technology, and so of social institutions, in the hands of scientists. Scientific discoveries of the past have, by and large, been given freely to the community; even the detailed applications have not often been patented. They have been exploited by others for private ends, sometimes in anti-social ways. As great industries of the present have arisen from past research, so surely those of the future are being born in the laboratories to-day. If individual scientists or, better, single universities or, better still, national scientific societies or, best of all, a distinguished body representing all science, and government as well—as the National Academy of Sciences or the National Research Council (to consider the national rather than the international level which must eventually supersede it) —were to patent future discoveries and control their development and their impact on society we would have a better world. Not perfect, ever, but improving, probably; and surely with a greater chance of success than when, as now, the implements of propaganda and control are allowed to fall into the most grasping and ruthless hands.

Scientists are more men of thought than action, they prefer to have the evidence, which is never all in. All agree that, to-day, by applying known or strongly surmised genetic laws to man the breed could be altered very considerably. But they are not certain what to breed for, have little control of the breeding, and fear the consequences of mistakes in the form of ill-begotten beings which may not be destroyed. All agree that, to-day, with a growing knowledge of educational aims and techniques, with a sound child psychology, the thoughts and even the more important motives that determine action could be modified. But they are not certain of what to educate for, have little control of mass education, and fear the consequences of mistakes in the form of neurotic misfits which may not be curbed. This attitude is sound—but only if time permits a proper evolution. This is not so; power multiplies and usurpers are reaching for it, dictatorship is in the air, events are rushing a decision. I believe that men of good-will must act; I would rather trust the destiny of civilization to even a second-rate group of scientists and educators than to the present type of dictator. They at least would aim for truth and profit by errors. Perhaps the world will owe Hitler a debt of gratitude, after all, for pointing the issue sharply enough to force better men to act.

A final word. The fate of our institutions and culture depends, when all is said, on the few who wield great power. Whether scientists, bankers or politicians, they remain still men. The great questions are: first, is the human intellect capable of solving, at any time in the future and with any amount of scientific analysis and even experiment, the labyrinthine problems of human relations; and, second, will not might forever make right, so that the selfish, ruthless and aggressive will arrogate control, however the game is played? The answers lie in the future, yet I shall be reckless and assume the role of prophet for the nonce.

Science is not able to deal with all nature. We have already seen that the individual as an individual is outside its province. The "private" lives of each of us may be penetrated by esthetic or religious or scientific experience but are not subject to scientific analysis. But the class, even the individual as an organization of simpler units, lies within its capacities; and social problems are no more insoluble than biological ones. Man's understanding and control of the body to-day are no less than they were of inanimate nature a century back. Living things are vastly more complex than non-living, just as social beings are more so than solitary ones. Each complexity as it is approached seems to resolve itself into many simpler problems and the mind has rolled over them. It is as gratuitous an assumption that man's intellect will be baffled at the level of social analysis as was the one that blood would spurt from his nose if he moved at the frightful speed of fifteen miles an hour. I see in question one no cause for pessimism.

The second is more uncertain in my mind. The human brain contains an old portion, the hypothalamus, essentially like that of all his vertebrate relatives, and a new portion, the cerebral cortex, most richly expanded in him alone. The old brain is concerned

with the emotions, the new one with intelligence. Fear and rage he shares with all, judgment and foresight are almost uniquely his. It would probably be impossible, surely unwise, to eliminate the selfish elements of self-preservation from man's make-up; but it may be possible and is surely desirable to control and guide them. Knowledge is cumulative in time, generation building on generation, while emotion is not. Perhaps cerebral control is increasing. Modern psychiatry is finding the hidden springs of behavior and modifying their flow. Men will probably always want more than their share, but perhaps it will not always be of the same things. The mass desideratum now is money, yet large groups of men have completely renounced this end for another; for example, fame. As man learns more of himself, his neural mechanisms, the hormones that modify them, the drives they generate, and the personal and social consequences of his acts, much control will undoubtedly be possible. And this knowledge will be deposited only by the stream of science. I am perhaps not overly guileless in believing that reason will sufficiently dominate emotion to keep a functioning civilization from perishing. Some emotion is needed, but the future of society is a direct challenge to the cerebrum of man and to its tool for rational advance—pure science.

OBITUARY

ALBERT SHERMAN

DR. ALBERT SHERMAN, research associate and Stephen S. Wilder fellow of the Basic Science Research Laboratory at the University of Cincinnati, died suddenly on July 1, following a period of illness. He was a brilliant theoretical chemist and probably the leading authority on the practical application of activation energy calculations to chemical reaction rates. His death at the age of 31 is a handicap to the development of this new and important branch of chemical kinetics. He has written twenty articles in the field of mathematical chemistry published in several journals, but chiefly in the *Journal of Chemical Physics*.

Born and raised in San Francisco, Dr. Sherman was graduated from the chemistry department of the University of California and went to Princeton University, where he received the Ph.D. degree in 1933. Here he came under the stimulating influence of Professor Eyring and Professor Taylor, and in this period published several articles in the rapidly developing application of quantum mechanical calculations to chemical problems such as adsorption, and deuterium reactions. He received a National Research Council fellowship and went to the University of Wisconsin, where he remained as fellow and research associate with Professor Daniels until 1937, except for a second appointment to a National Research Council fellowship to study in England with Professor Lennard-Jones.

Of this period of his scientific work, three outstanding papers are typical—a long review article with Professor J. H. Van Vleck on the "Quantum Theory of Valence," an article on the "Addition of Halogens to the Double Bond" and an article with Moelwynn-Hughes on the various types of interaction between solvent and solute and their influence on reaction rates.

A year ago Dr. Sherman was appointed to an interesting position on the staff of the Basic Science Research Laboratory at the University of Cincinnati. He had the opportunity of giving advanced courses in quantum mechanics, valence and thermodynamics, directing research and cooperating with the industries around Cincinnati. At the Symposium on Recent Advances in Chemical Physics of the American Association for the Advancement of Science, Dr. Sherman gave a paper on the "Calculation of Activation Energies," and in a forthcoming book he has contributed a chapter on the "Theoretical Basis of Halogenation Reactions."

Not only in his publications has Dr. Sherman helped to advance chemistry but also in the help which he was constantly giving to other investigators. He was liked and respected by all the graduate students with whom he came in contact at Cincinnati, at Wisconsin and at Princeton. His advice was eagerly sought by many in getting the most possible out of a series of experimental measurements, and both in formal lectures and informal conferences he stimulated others to more mathematical and more valuable treatment of chemical problems.

Dr. Sherman is survived by his parents and a sister in San Francisco. He is survived by Dr. Jack Sherman, an identical twin brother, who is also a prominent mathematical chemist, located at the laboratory of the Universal Oil Products Company.

FARRINGTON DANIELS

ELLIS STANLEY JOSEPH

THE death of Ellis S. Joseph from a heart attack on September 16 ended the career of one of the world's foremost animal collectors. Mr. Joseph was 66 years old, and had been in virtual retirement for the past five years due to ill health.

Born in Bombay, India, of English parents, he was educated in an English school in Shanghai. His father, said to have been a wheat farmer and horse owner in India, wanted the son to become a doctor. But the lure of travel and adventure was too strong, and when only eighteen the young Joseph began making expeditions

into the wild country in India, bringing back rare birds and animals. As he grew older, his horizons widened, and he was soon traveling into the most remote parts of Asia, Africa and Australia, selling his finds to zoos all over the world. Before the world war he established an animal farm near Sydney, Australia, which he used as his headquarters and clearing house. In 1923 he moved his headquarters to New York.

His quest for the rare and the difficult took him to almost every country in the world. He was one of the few collectors who obtained and cared for his specimens with his own hands. He consequently had remarkable success in securing the most unusual specimens and in delivering them to buyers in excellent condition. A complete enumeration of his almost superhuman achievements is impossible. Once, in Sierra Leone, an infant chimpanzee, about to die, was saved by persuading a native mother to nurse it for several weeks. On his first visit to New York in 1920, he brought a record-breaking shipment of camels and other animals, and in that same year delivered to the New York Zoological Park the first blue-birds of Paradise ever seen here. He also brought over the lungfish and the first Australian koala to be seen in this country.

On July 13, 1922, he delivered to the New York Zoo the first and only duckbill platypus ever held in captivity. The platypus lived only 49 days in New York, but the method used to transport the animal to this country still provides anecdotal material among animal collectors. For half a century the platypus, which thrived in a certain kind of watery habitat, had resisted all attempts to transplant it from Australia. After working five years on a scheme to duplicate the conditions under which the animal lives, Mr. Joseph devised the "platypusary"—a cage containing a system of water tanks through which the animal swam to a dry burrow. As the platypus ascended from the water into the sand it passed through a series of rubber gaskets which squeezed the surplus water off its body.

Mr. Joseph was so reticent and shy of publicity that much of the story of his life was never told. On several occasions, when besieged by newspaper men or by publishers desiring him to recount his adventures in book form, he refused; and it was to only a few intimate friends that he would occasionally describe his experiences in the bush.

His physical appearance was arresting. A huge figure of a man, more than six feet tall and weighing nearly 300 pounds in his prime, he was noted for his fearlessness, and his arms and hands were covered with scars where carnivores, parrots and big birds had ripped into his flesh. One arm was marked by a long scar where a black panther had slashed him. On five different occasions he had been forced to sew himself up when wounded by animals far from civilization. His face bore scars as the result of the "affectionate" reactions of a large male chimpanzee which he had not seen for several years.

Ellis Joseph was a true zoologist, ecologist and comparative psychologist. His knowledge concerning the morphology and behavior of various birds and mammals was unexcelled. He was particularly eager to cooperate with scientists throughout the country, and would often go out of his way to supply a laboratory with desired research animals. Once, rather than sell the body of a young gorilla for less than it was worth, he donated the animal for study to a well-known comparative anatomist. He was an honorary life member of the American Museum of Natural History and of the Philadelphia Zoological Society.

Mr. Joseph had the universal respect of all those who knew him. His reputation was impeccable; his word was his bond. He was exceedingly generous and a most gracious host. He sought perfection, and had a singular love for the unusual and the esoteric; these were reflected in everything that he had and did.

Ellis Stanley Joseph is dead. He has joined Carl Akeley and Martin Johnson, and has completed the triumvirate. But his spirit lives on in the African bush, Australian plain, Tibetan highland and Malayan jungle, as well as in the memories of those who knew and loved him.

John P. Foley, Jr.

Department of Psychology,
The George Washington University

RECENT DEATHS

Dr. E. W. Rettger, professor of applied mechanics at Cornell University, died on October 9 at the age of sixty-seven years.

Dr. Raemer Rex Renshaw, professor of organic chemistry at New York University, was killed on September 23 by a fall from the window of his apartment. His wife was killed at the same time in the same manner. Dr. Renshaw had been on leave, but was expected to resume his work at the university on September 28. He was fifty-eight years old.

The death is reported in *Nature* of Sir Philip Dawson, a distinguished electrical engineer, who received the George Stephenson Gold Medal of the Institution of Civil Engineers and also the Albert Medal of the Royal Society of Arts, on September 24 at the age of seventy-one years.

Dr. F. J. Karl Sudhoff, professor of the history of medicine at the University of Leipzig and founder of the German Society for the History of Medicine, died on October 14. He was eighty-four years old.

The death on June 30 at the age of seventy-five years is reported of Dr. Waichiro Okada, honorary professor of otorhinolaryngology at the Tokyo Imperial University and president of the Showa Medical College, which he founded.

SCIENTIFIC EVENTS

HURRICANE DAMAGE TO THE STATIONS OF THE BUREAU OF FISHERIES

IT is reported in the *Bulletin* of the Fisheries Service that several of the bureau's stations were in line of the hurricane which visited the New England States during the week of September 19. Fortunately, no injury was suffered by members of the personnel. Superintendent Goffin of the Woods Hole, Mass., station writes in regard to the situation there:

> You have probably been informed of my telegrams to the commissioner relative to the hurricane and tidal wave which struck this village the afternoon and night of September 21. The wind and sea were terrific, the east dock and sea wall is practically gone, the coal dock, west dock and south docks are badly damaged, the capstones of the sea wall have been knocked out. All basement windows and doors of the residence building are smashed; this basement had 6 feet of water which has been pumped out by the local fire department. We were able to get up steam on the boiler and syphon out the hatchery building. Six of our pontoons are a total loss, having been swept out to sea; the sea entered the buildings through the front door and basement windows. The slate roofs of both the residence and the hatchery building are badly damaged. The fence along the street has been mostly carried away and the grounds between the residence and sea wall are badly washed out. The boilerhouse had 3 feet of water, but this disappeared when the waters receded, leaving very little damage there; the basement of the residence building has a great deal of debris, seaweed and sand washed in from the sea. We are without lights and can not cook until the gas company gets its mains in operation. I am happy to say that out of all this havoc our boat, the *Phalarope II*, was damaged very little so far as I can now see. The salt water suction pipe line, where it lay along the wall, is practically all destroyed. As it is now, the property and the *Phalarope* are without protection against the winter storms due to the loss of the east side sea wall.

The Nashua, N. H., station was damaged by the uprooting of a number of trees which caused injury to buildings and damage to the ponds. It is estimated that the amount of $15,000 will be necessary to rehabilitate this station. Both the Gloucester, Mass., and the Boothbay Harbor, Maine, stations escaped without any appreciable damage. At the Pittsford, Vt., hatchery the creek overran the station grounds and flooded out the ponds. The brood stock was thoroughly mixed, but comparatively few fish were lost. Mr. Lord, in charge at Pittsford, reports, however, that many wild trout were undoubtedly destroyed, since they were discovered stranded, in numerous instances, along the line of débris marking the high water. A bridge, the property of the bureau, was washed out, but the structure was to be razed within the next few days.

The oyster laboratory at Milford, Conn., escaped damage, although the Yacht Club building located next to the station was demolished and a large number of elm trees surrounding the station and along the street leading to it had fallen. The station grounds were under from 1 to 3 feet of water, but all the equipment and material had been placed on higher shelves or otherwise made secure.

THE PRACTICE OF MEDICINE AND THE PRACTICE OF CHEMISTRY

AN attempt to deprive chemists of the right to direct clinical laboratories in Pennsylvania is being opposed by the American Chemical Society. The society, according to an announcement made by the secretary, Dr. Charles L. Parsons, of Washington, D. C., has filed a brief through its attorney, A. J. Nydick, of Philadelphia, with the Attorney General of Pennsylvania setting forth "the clear demarkation between the practice of medicine and the practice of chemistry."

Dr. Parsons states that:

> Evidence in the possession of the society shows that there has been an organized effort to wrest from the chemist his natural position in the field of factual investigation in the laboratory. This evidence shows that the attempt originates with a small group of laboratory physicians with obvious self interests.
>
> The method adopted is to have the existing law so interpreted by the State Board of Medical Education and Licensure as to make it unlawful for any one not having the M.D. degree, no matter how well qualified, to direct such laboratories.
>
> Between the practicing physician and the chemist who directs and operates a clinical laboratory there exist the most cordial professional relationships, but, notwithstanding the esteem in which the qualified chemist is held by the practicing physician and in spite of a joint resolution adopted in 1924 by the American Chemical Society, the American Medical Association, and the American Association of Pathologists and Bacteriologists with respect to the rights of chemists, certain organizations of physicians affiliated with the American Medical Association have seen fit to support the contentions of the small group which is attempting to monopolize the directorships of clinical laboratories.

The brief describes the scope of the science of chemistry, recalls medicine's indebtedness to chemistry, defines a clinical laboratory as a specialized chemical laboratory, and declares that "the right to pursue a profession is a property right which is protected by the Constitution of the United States."

The Board of Medical Education and Licensure, it is explained, has taken the position that the 1935 amendments to the Medical Practice Act of 1911 so enlarged the Act that "the operation of a clinical laboratory now constitutes the practice of medicine."

The society, on the other hand, contends that clinical laboratories are not engaged in the practice of medicine, but rather are laboratories for the practical application of chemistry and the other fundamental sciences "wherein are made such factual investigations for the physician as he may desire in the study of his patients." Laboratory investigation, it is asserted, is not diagnosis of diseases because the physician must integrate laboratory findings with all other relevant clinical data in reaching a diagnosis.

THE ELI LILLY PRIZE IN BIOLOGICAL CHEMISTRY

ATTENTION is again directed to the Eli Lilly and Company Prize in Biological Chemistry, an annual award whose purpose is to stimulate an interest in fundamental research in biological chemistry on the part of young men and women in the United States. It was established by Eli Lilly and Company in 1934 for a five-year period and is administered by the American Chemical Society. The award is the sum of $1,000 together with a bronze medal and $150, or as much thereof as is needed, to defray the traveling expenses of the recipient to the spring meeting of the American Chemical Society where he formally receives the honor and gives an address describing the work on which the award is given.

To be eligible for the award, a nominee shall not be over thirty-five years of age on April 30 of the year of the award and shall have accomplished outstanding research in biological chemistry, working in a college or university. For the purpose of this award biological chemistry does not include immunology, clinical investigations, pharmacology or experimental therapeutics, and outstanding research is understood to be that which is of unusual merit for an individual on the threshold of his career. The research is not to be judged in comparison with the work of more mature and experienced chemists, and special consideration is given to the independence of thought and the originality and resourcefulness shown.

The award is made by an award committee of seven, consisting this year of Charles A. Kraus, president-elect of the American Chemical Society, as chairman, and the following non-industrial biological chemists appointed by the president-elect: Wm. Mansfield Clark, Glenn E. Cullen, R. Adams Dutcher, H. B. Lewis, P. A. Shaffer and D. D. Van Slyke. Nominations of the award must be made as follows:

Nominations for this award should be sent to the secretary of the society by any member of the society except the members of the Award Committee. No member may send in more than one nomination. Nominations shall be accompanied by a brief biographical sketch of the nominee, including date of birth, and by reprints of his publications, with specific reference to the research on which the nomination is based. At the time of the nomination the nominee must be actively engaged in the line of research for which the award is to be made. The sketch, information and reprints should be in the form of seven copies for distribution by the chairman of the members of the Award Committee.

All nominations to be considered must be received by the secretary of the society on or before January 5, 1939.

In order to insure that no outstanding young chemist shall be overlooked, a Nominating Committee of four, appointed by the president of the society, is charged with the duty of finding worthy nominees for the award, by themselves searching the literature and suggesting his nomination to individuals familiar with his work; also, by writing to others who are in a position to judge the qualifications of individuals and to make worthy nominations.

The members of the present Nominating Committee are H. A. Mattill, University of Iowa; Lawrence Bass, Mellon Institute, Pittsburgh; V. du Vigneaud, Cornell University Medical College, New York City, and Ben H. Nicolet, U. S. Department of Agriculture, Riverdale, Maryland. The members of this committee wish to receive and exchange suggestions with regard to suitable candidates.

The nominations themselves, together with the substantiating documents, should be sent directly to the Secretary of the American Chemical Society, Dr. Charles L. Parsons, Mills Building, Washington, D. C.

If in the opinion of the Award Committee there is no outstanding nominee from a United States college or university, the award may be passed and the fund used for a later award.

The chemist selected will receive the prize at the Baltimore meeting of the society next spring.

The nominating committee requests that information regarding this prize be disseminated as widely as possible and especially that it be brought to the attention of those who are located in college and university centers of biochemical research.

APPOINTMENTS AT THE MEDICAL COLLEGE OF VIRGINIA

THE session opening the second century of the Medical College of Virginia began on September 19. Faculty promotions for the session 1938–1939 include:

Dr. Stuart Michaux, professor of gynecology; Dr. R. H. Courtney, professor of ophthalmology; Dr. R. Finley Gayle, professor of neuropsychiatry; Dr. Thomas W. Murrell, professor of dermatology and syphilology; Dr. Lee E. Sutton, Jr., professor of pediatrics; Dr. William D. Suggs, assistant professor of gynecology. Dr. Wyndham B. Blanton, who resigned last session as professor of history of medicine, has been made associate professor of medicine. Dr. Joseph F. Geisinger has been appointed professor of clinical urology.

In recognition of many years of service to the in-

stitution the following have been made emeritus professors following their retirement on July 1, 1938: Dr. St. George T. Grinnan, emeritus professor of pediatrics; Dr. Emory Hill, emeritus professor of ophthalmology; Dr. E. P. McGavock, emeritus professor of dermatology and syphilology; Dr. Charles R. Robins, emeritus professor of gynecology, and Dr. Beverley R. Tucker, emeritus professor of neuropsychiatry.

In the School of Dentistry Dr. Grant Van Huysen has resigned as assistant professor of anatomy and Dr. Alton Brashear has been appointed in his place as associate in anatomy. Dr. Webb B. Gurley has resigned as assistant professor of operative dentistry and Dr. H. D. Coy has joined the staff as professor of operative dentistry. Dr. A. Hubert Fee has been promoted to assistant professor of operative dentistry.

In the School of Pharmacy Dr. J. A. Reese has returned from the University of Florida, where he recently completed his work for the Ph.D. degree. He has been made assistant professor of pharmacognosy.

In the School of Nursing Miss Frances H. Zeigler, dean of the school of nursing, and Miss Lulu K. Wolf, associate professor of nursing, have resigned to accept similar positions at Vanderbilt University. Miss Ann Parsons has been made acting dean of the school of nursing for the session 1938–39.

The Public Works Administration has made a grant of $880,623 towards the construction of a new sixteen story hospital and the rehabilitation of the historic Egyptian Building. The total construction cost is estimated at $1,920,441.

IN HONOR OF DR. AUGUST KROGH

THE honorary degree of doctor of science was conferred on Dr. August Krogh by Rutgers University on October 11. Dr. Krogh was one of the principal speakers at the dedication of the new research laboratory of the Squibb Institute for Medical Research at New Brunswick. The presentation of Dr. Krogh was made by Dr. William H. Cole, professor of physiology at the university. He said:

All of us who are engaged in research in physiology, wherever our researches may have been conducted, have in spirit, at least, sat at the feet of Dr. Schack August Steenberg Krogh. Dr. Krogh first won international recognition when he received the Vienna Academy of Science prize for his work on the gaseous exchange in lungs.

Brilliant investigator of respiration, he published in 1916 his authoritative volume on "Respiratory Exchange in Animals and Men." In a related field he extended his researches to the functions of the capillaries, and in 1920 was awarded the Nobel Prize in physiology and medicine. While Silliman Lecturer at Yale, he published in 1923 his second authoritative volume "The Anatomy and Physiology of Capillaries." Subsequently he has boldly attacked other secrets of nature, investigating life in salt and fresh water, studying the effects of heavy water on organisms and the innervation of cold spots in the skin. His example and influence, Mr. President, have stimulated the efforts of physiologists the world over and greatly augmented our wealth of scientific knowledge. I have the honor to present Dr. Schack August Steenberg Krogh for the honorary degree of Doctor of Science.

The citation made by President Robert C. Clothier read:

Dr. Krogh, your long and distinguished pursuit of truth among the mysteries of life has lighted dark places in the borderland of human knowledge. You have exerted a profound influence upon the endeavors of your fellow physiologists. Your researches have enriched our scientific heritage. With the approval of the trustees of Rutgers University it is my privilege to confer upon you, honoris causa, the degree of Doctor of Science.

SCIENTIFIC NOTES AND NEWS

PROFESSOR R. H. FOWLER, at his own request for reasons of health, has been released from the engagement to assume the directorship of the British National Physical Laboratory in succession to Dr. W. L. Bragg. Dr. Charles Galton Darwin, master of Christ's College, Cambridge, has been appointed in his place. For the period until Dr. Darwin can take up the work, the office of director will be held by Sir Frank Smith, secretary of the Department of Scientific and Industrial Research.

THE evening lecture at the autumn meeting to be held at the University of North Carolina of the National Academy of Sciences will be given on the evening of Monday, October 24, by Dr. E. C. Stakman, professor and head of the department of plant pathology at the University of Minnesota. His subject will be "Plant Disease Fungi Constantly Evolving New Types."

A PORTRAIT of Dr. Henry A. Christian, physician-in-chief at the Peter Bent Brigham Hospital, was presented to the hospital corporation on October 13. Dr. Christian will retire next year. The portrait was accepted by William Amory. Dr. Elliott C. Cutler, surgeon-in-chief, spoke of Dr. Christian as "a man whom we deeply respect and greatly admire, one whose devotion to this hospital and whose name will travel down the years as part of our institutional tradition."

THE doctorate of laws was conferred at the closing session on October 14 of the seventy-fourth convocation of the University of the State of New York on Dr.

James Rowland Angell, president emeritus of Yale University and educational counselor of the National Broadcasting Company. He was presented with the degree by Owen D. Young. Dr. Angell was professor of psychology at the University of Chicago from 1894 to 1920.

Dr. Gordon W. Allport, associate professor of psychology at Harvard University, was elected president at the recent Columbus meeting of the American Psychological Association.

Officers of the American Dairy Science Association for next year are: *President,* Professor Earl Weaver, East Lansing, Mich.; *Vice-president,* Dr. E. S. Guthrie, Cornell University, who under association rules will automatically become president next year; *Secretary,* Professor Robert B. Stoltz, of the Ohio State University; *Directors* elected to serve for three-year terms are Professor J. W. Linn, extension specialist in dairying, Kansas State College, Manhattan, and M. E. Parker, Beatrice Creamery Company, Chicago. At the annual meeting to be held next June, the program will be divided between the state agricultural colleges at Moscow, Idaho, and Pullman, Washington, which are only nine miles apart.

Before sailing for New York on October 1, Dr. Henry Hanson, traveling representative of the Pan American Sanitary Bureau, was decorated with the Order of Merit of the Ecuadorean Government, in recognition of his services in Ecuador in fighting the bubonic plague. The decoration was presented by Dr. Leopold Izquieta, secretary of education.

Dr. Richard P. Strong, since 1913 professor of tropical medicine at the Harvard Medical School, has retired from active teaching and has been named professor emeritus.

Professor Hugh Gray Lieber, of Long Island University, and Dr. L. R. Lieber, director of the Galois Institute of Mathematics, have been appointed visiting professors of modern mathematics in the Graduate School of Duquesne University, Pittsburgh.

A department of forestry has been established at the Illinois Experiment Station, under the directorship of Dr. John Nelson Spaeth, who has been assistant professor of forestry at Cornell University and silviculturist of the Cornell station. Associated with him will be J. E. Davis, extension forester of the college and the State Natural History Survey, and L. B. Culver, assistant in forestry extension.

Dr. Gregory Pincus has been appointed visiting professor of experimental zoology at Clark University. Dr. N. T. Werthessen and Dr. Mark Graubard have been appointed research associates to collaborate with Dr. Pincus in his studies of the mammalian egg.

Dr. Elbert C. Cole, professor of biology at Williams College, has received a research grant for study at the Marine Biological Laboratory at Woods Hole, Mass.

At the University of London, Dr. F. R. Winton, reader in physiology at the University of Cambridge, has succeeded Professor J. H. Gaddum in the chair of pharmacology; Dr. H. H. Woollard, professor of anatomy, has become head of the department of anatomy and embryology, on the retirement of Professor J. P. Hill from the chair of embryology; Dr. G. R. de Beer, formerly lecturer at the University of Oxford, has been appointed reader in embryology.

Dr. Harold James Plenderleith has been appointed deputy keeper in charge of the Research Laboratory of the British Museum, in succession to Dr. Alexander Scott, who has been honorary director of the laboratory since its establishment in 1919.

Dr. Kemp has been appointed director of the Danish Institute for Human Heredity and Racial Hygiene of the University of Copenhagen.

Dr. Harold J. Conn, chief of the department of research in soil bacteriology in the New York Agricultural Experiment Station at Geneva, N. Y., and chairman of the Committee for the Standardization of Biological Stains, has taken up special work at the Scripps Institution of Oceanography of the University of California, where he plans to stay until the end of the year. He is making a study of the growth of soil bacteria in synthetic or prepared soils, using materials found in deep-sea bottom deposits.

Dr. Comfort A. Adams, Abbott and James Lawrence professor of engineering and Gordon McKay professor of electrical engineering, emeritus, at Harvard University and consulting engineer to the Edward G. Budd Manufacturing Company, Philadelphia, has been appointed a member of the advisory committee of the thirteenth Exposition of Power and Mechanical Engineering, to be held in New York City from December 5 to 10.

Dr. Dugald C. Jackson is preparing for the Engineers Council of Professional Development a report on trends in engineering education, in which he has the cooperation of Dr. Dugald C. Jackson, Jr., formerly director of the Lewis Institute of Chicago.

Dr. Alexis Carrel, of the Rockefeller Institute for Medical Research, returned to New York on October 8. He will carry on his work at the institute during the winter.

Dr. Barnum Brown, curator of fossil reptiles at the American Museum of Natural History, and O. S. Chapin, of Calgary, Alberta, left New York on Sep-

tember 15 for an aerial survey for dinosaur remains over Montana and the province of Alberta, Canada. A new model Fairchild plane will meet the party at Billings, Mont., the starting point of the survey. The principal bases will be Calgary and Edmonton.

DR. PAUL S. MARTIN, chief curator of the department of anthropology at the Field Museum of Natural History and leader of the archeological expedition which has made during the season of 1938 an extensive survey in Montezuma County, Colorado, and the adjoining country, returned to Chicago on October 16. It will now be possible from the data and artifacts collected to construct a complete sequence of the history of the earliest known inhabitants of southeastern Colorado—the prehistoric Basket-maker Indians who occupied the region from about A.D. 600 to 1200.

DR. EMMANUEL FRITZ, associate professor of forestry in the University of California, has leave of absence for three months in order that he may assist in the preparation of a report on the coordination of forestry activities in the Department of the Interior. While in Washington he will be stationed in the Division of Forests.

DR. ARTHUR H. COMPTON, professor of physics at the University of Chicago, lectured at a convocation at Wayne University on October 17. His address was entitled "Shall Science Point the Way?"—a discussion of the relationship between scientific and religious thought.

PROFESSOR WALTER MULFORD, head of the Division of Forestry of the College of Agriculture of the University of California, delivered the principal address at the convocation of the University of Michigan on October 7, when the thirty-fifth anniversary of the founding of instruction in forestry was commemorated. Professor Mulford was a member of the department of forestry from 1905 to 1911. He spoke on the progress and policies of the Michigan School of Forestry.

DR. A. V. KIDDER, chairman of the Division of Historical Research of the Carnegie Institution of Washington, is giving on Monday and Thursday afternoons, beginning on October 17, a series of eight Lowell lectures on "The Pre-Columbian New World" in the lecture hall of the Boston Public Library.

IN order to meet the need for pathologists skilled in the diagnosis of tumors, the Surgeon General of the Public Health Service has announced that in making appointments for training under the provisions of the National Cancer Institute Act, special consideration will be given to qualified pathologists who wish to secure additional training and instruction in the pathology and diagnosis of tumors.

SEVERAL Benjamin Peirce instructorships at Harvard University are open for the academic year 1939-1940. These instructorships are ordinarily awarded to men who have recently received the Ph.D. degree or have had equivalent training. Those interested in applying should write to the chairman of the Division of Mathematics.

ACCORDING to the constitution of the American Society of Naturalists, members may submit to the executive committee names of candidates for membership. Such nominations must remain in the hands of the executive committee for at least one year before action can be taken upon them. Members of the society are invited to send nominations at this time to the secretary, Ralph E. Cleland, department of botany, Indiana University, Bloomington, Ind.

THE Premio Alvarenga do Piauhy (Brazil) Prize for 1939, about $200, will be conferred by the College of Physicians of Philadelphia on July 14, 1939, upon the author either of the best memorial or of the best unpublished essay on any branch of medicine which may be deemed worthy of the prize. In selecting the winner of the award the committee will consider recent publications brought to its attention prior to May 1, 1939; also unpublished typewritten manuscripts submitted to the committee before that date. Manuscripts not in English must be accompanied by a translation into English.

THE School of Medicine of the University of Pennsylvania will receive eventually the bulk of the estate of the late Dr. George E. de Schweinitz to found a chair of ophthalmology. Except for one bequest of $6,000, the estate of $105,000 was left in trust for a sister of Dr. de Schweinitz. After her death $5,000 will go to the College of Physicians of Philadelphia and the residue to the university. His medical library is left to the College of Physicians.

WESTERN RESERVE UNIVERSITY came into possession of the principal of the Albert Fairchild Holden Trust Fund on August 25, which was the twenty-fifth anniversary of the death of the late Liberty E. Holden, who established the foundation as a memorial to his son. The fund, which, at a conservative estimate, is said to be worth a million and a half dollars, will continue to be used, as directed by Mr. Holden, for lectures and research in the School of Medicine. The trustees of the foundation are Ben P. Bole, I. F. Freiberger and Guerdon Holden.

THE estate of the late Richard Crittenden McGregor, an ornithologist who was attached to the Philippine Bureau of Science for nearly thirty-five years, has presented to the Museum of Vertebrate Zoology of the University of California his collection of Philippine and Alaskan bird specimens. The collection includes

approximately eight hundred specimens, some of the species being now extinct.

The U. S. Coast and Geodetic Survey has erected a new building at the seaward end of the 1,200-foot pier of the Scripps Institution of Oceanography at La Jolla. It is forty-five by ten feet and is part of a general program of improving the recording tide-gauge stations. Dr. G. F. McEwen, official tidal observer of the U. S. Coast and Geodetic Survey at the Scripps Institution, has been put in charge of construction. In addition to the instruments used in the tidal work, the building will contain equipment for routine observations of meteorological and hydrographic conditions, and for biological studies.

By a cooperative agreement recently concluded between the U. S. Department of Agriculture and the Iowa State College, the statistical laboratory of the college will undertake to perform important services for and with the department, and to this purpose it is increasing both staff and equipment. Provision is made for the addition to the staff, of which Professor G. W. Snedecor is director, of a professor of mathematical statistics, an instructor, four graduate assistants, two collaborators and a sufficient number of clerical assistants. The purpose of the enlarged laboratory is research in the statistics of agriculture and associated statistical theory. One project is the study of the relation between weather and crop yield. Weather conditions to be considered are change and range of temperature, rainfall, wind. Partial census methods—whose investigation is of great concern to the laboratory—are used for the estimation of acreage and condition of the crop, for the sake of early prediction of yield. In the study of weather prediction, the Massachusetts Institute of Technology is cooperating. Products to be given early consideration are corn, wheat (with the aid of Kansas State College) and cotton. By the study of sampling techniques it is hoped to be able to learn significant economic and social facts of rural life more efficiently and reliably. A further topic of investigation is the analysis of time series.

During the recent crisis in Great Britain the aeroplane of 1903 in which the Wright Brothers made their first flight, which has been exhibited on loan in the Science Museum, South Kensington, for the past ten years, was removed to a place of safety in the vaults of the museum.

DISCUSSION

THE HISTORY OF MATHEMATICS FORTY YEARS AGO

In 1898 the publication of the now widely used "Encyklopädie der mathematischen Wissenschaften" was begun. The first article thereof relates to arithmetic and includes a considerable number of historical statements relating to this subject. It may be assumed that these statements represent about the highest mathematical attainments at the time when they appeared, since this is the most extensive recent mathematical encyclopedia, and more than 200 scholars of various countries cooperated in its preparation. Hence it may be of interest to compare the views contained in some of these statements with those which are now current with a view towards noting progress along various mathematical lines during the last forty years. In particular, the historical statements may be of wide interest, since they can be readily understood and relate to the early training of almost all educated people.

Since note 18 on page 12 of Volume 1 contains an especially large number of statements which have been disproved since their appearance therein we begin with several of these assertions. This note relates to negative numbers and in the third sentence thereof it is asserted that the first traces of these numbers appear in the works of the noted Indian mathematician Bhaskara (born in 1114) who distinguished between the positive and the negative square root of a number. It is now well known that, on the contrary, even the Indian mathematicians used negative numbers more than 500 years earlier and that, in particular, Brahmagupta (born in 598) placed a dot above a number to indicate that it is negative. It is therefore far from correct to say that the first traces of negative numbers appear in the work of Bhaskara. In the following sentence of the given note it is asserted that the Arabs recognized negative roots of equations, which is also now well known to be untrue.[1]

The last sentence of the given note contains two misstatements relating to R. Descartes (1596–1650). The first of these is that the actual calculating with negative numbers begins with R. Descartes, while it is now commonly known that such calculatings are posterior to R. Descartes as is also stated in the corresponding note (149) of the French edition of this encyclopedia, page 35 (1904). The said second misstatement in the sentence is that R. Descartes gave to the same letter sometimes a positive value and sometimes a negative value, while, on the contrary, R. Descartes always assumed that a letter represents only a positive number when it is assumed to have a numerical value. It is, however, true that by placing a dot before a letter R. Descartes implied that either a positive or a negative number may be assigned to the letter.

[1] *Cf.* Tropfke, "Geschichte der Elementar-Mathematik," Volume 2, page 97, 1933.

Although note 24 (page 21) of the article in question involves comparatively few incorrect assertions it contains one which is so extremely bad that the note as a whole is perhaps even worse than the note 18 to which we have referred. In the former it is stated that the sexagesimal system of the ancient Babylonian astronomers involved 59 different numerical symbols. This would correspond to the 9 different digits in our decimal system, but there is no historical evidence that such a complex early system ever existed. It is now well known that the ancient Babylonian sexagesimal system was partly based on the number 10 and that the numbers up to 60 were represented with respect to this smaller base.[2]

It is not implied that all the historical notes in the widely used encyclopedia noted in the opening sentence of this article are in need of radical revision. On the contrary, the majority of them are still reliable, especially those which relate to the more advanced parts of our subject. It may, however, be of interest that some of these notes which relate to the most elementary parts of our subject should now be used with great caution, since historical progress during the last decade or two has been especially rapid with respect to school mathematics, where it might have been least expected. In particular, the history of negative numbers as it is presented in some of our general histories of mathematics is very misleading notwithstanding the fundamental rôle of these numbers in various developments relating to school mathematics. It is questionable whether in any other large field of mathematics the progress during the last forty years has been more profound than in its history.

G. A. MILLER

UNIVERSITY OF ILLINOIS

[2] *Cf.* O. Neugebauer, "Vorlesungen über Geschichte der Antiken Mathematischen Wissenschaften," Volume 1, page 4, 1934.

MEDITERRANEAN SEDIMENTS AND PLEISTOCENE SEA LEVELS[1]

THE magnitude of the sea level changes during the glacial stages of the Pleistocene are of interest not alone for their bearing on the origin of submarine canyons but also, among other things, for their effect on migrations of animals and plants. Antevs[2] and Daly[3] have independently suggested that the sea level was lowered 80 to 90 meters during the last glacial stage, whereas Shepard[4] has suggested that it was lowered perhaps as much as 900 meters.

An independent test of the hypothesis that sea level was lowered several hundred meters would probably be furnished by a study of the sediments in the western deep basin of the Mediterranean Sea. Long cores of these sediments, like the cores that Dr. C. S. Piggot obtained in 1936 from the North Atlantic, would probably make available the sedimentary record of post-Pleistocene time and part of the last glacial epoch.[5] Such records should be conclusive on the question of great lowering of ocean level because the unusual configuration of the Mediterranean Sea floor and the geographic setting make the hydrography not only peculiar but also sensitive to changes of ocean level and of climate.

Lowering the ocean level about 320 meters or more would profoundly alter the hydrography, and this would be reflected in the deep basins by the formation of varved sediment moderately rich in organic matter like that now forming in the Black Sea.

Lowering the ocean level considerably less than 320 meters, say 80 or 90 meters, would not give rise to varved sediment in the western of the two deep basins, though the glacial climate alone would probably give rise to varves in the eastern deep basin.

Lowering the ocean level 80 or 90 meters would affect the regimen of sedimentation less decisively, yet it seems that the effect should nevertheless be distinguishable, as is outlined below.

In order to show how these conclusions are reached it will be necessary to consider the present hydrography of the Mediterranean and the probable hydrography that existed during the last glacial stage when both the climate and the ocean level were different. A high sill at the Strait of Gibraltar separates the Mediterranean from the Atlantic and a comparable sill at the Sicily Straits divides the Mediterranean into two deep basins (Fig. 1). Over the crest of the sill at Gibraltar the deepest water is approximately 320 meters. In the Sicily Straits the deepest channel across the crest of the sill is 450 meters. These constrictions in the longitudinal profile have a significant bearing on the hydrography.

At present the Mediterranean Sea loses more water by evaporation than it receives from its tributary streams and from the overflow of the Black Sea. In consequence its level is maintained by influx of sea water from the Atlantic. The loss of water by evaporation is greatest in the eastern Mediterranean, so that the Atlantic water, with salinity of about 36 parts per thousand, drifting eastward becomes progressively more saline until near the Syrian coast it reaches a

[1] Published with the permission of the Director, Geological Survey, U. S. Department of the Interior.

[2] E. Antevs, *Amer. Geog. Soc. Research Ser.*, No. 17, p. 81, 1928.

[3] R. A. Daly, *Bull. Geol. Soc. Amer.*, 40: 724–725, 1929.

[4] F. P. Shepard, SCIENCE, 83: 484, May 22, 1936.

[5] C. S. Piggot, *Bul. Geol. Soc. Amer.*, 47: 675–684, 1936; W. H. Bradley, M. N. Bramlette, J. A. Cushman and others, *Am. Geophys. Union Trans.*, eighteenth annual meeting, pp. 224–226, 1937.

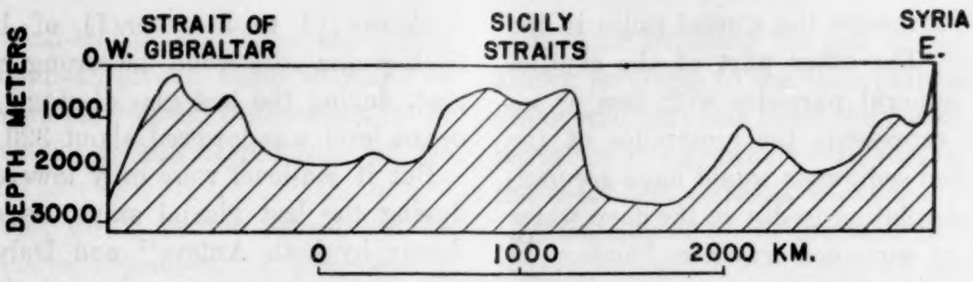

FIG. 1. Profile of greatest depth along the Mediterranean Sea.

salinity of about 39 parts per thousand and becomes so dense that, despite its increased temperature, it sinks to the bottom. This warm, heavy water then moves westward through the deeper parts of the Mediterranean, flows over the sill at Gibraltar, and thence flows down the continental slope till it reaches water of its own density (less saline but colder), where it spreads out in a great fan and eventually mixes with the ocean water. This slow circulation keeps the deep parts of the Mediterranean partly oxygenated, though in the western deep the supply of oxygen is small and the water contains a considerable percentage of carbon dioxide.[6]

Let us consider first what effect the climate of the last glacial stage had upon the hydrography of the Mediterranean Sea. According to Brooks[7] and according to the evidence from many sources assembled by Antevs[8] the climate was cooler and considerably more rainy than to-day. A greater volume of water would therefore have reached the Mediterranean from the increased rainfall and apparently also from the outlet of the Black and Caspian Seas because the Caspian, which then connected with the Black Sea, was receiving overflow from the Baltic and the Arctic.[9] Even under the present climate the Black Sea overflows, hence it seems safe to infer that this greater supply of water, together with the lessened evaporation rate consequent upon the cooler, stormier climate of the last glacial stage, would have caused the Mediterranean to overflow through the straits of Gibraltar. With enough fresh water entering to overbalance the loss by evaporation and cause overflow the hydrography should be analogous to that in the Norwegian fjords described by Strøm.[10] In those fjords a layer of fresh water floods the surface and protects the underlying deep body of salt water from the effect of the wind. Like the Mediterranean these fjords have a high sill at the seaward end. In many this sill is so high that there is room only for the stream of fresh water to pass over it. Thus the salt water in the fjord is sealed beneath a blanket where it becomes stagnant and ultimately charged with hydrogen sulfide. This sort of water stratification is stable and, curiously enough, more persistent the more fresh water flows across the surface of the dense saline water.[11] But in other fjords the sill is not so high and by reason of storms and abnormally high tides oxygenated and somewhat colder ocean water at least partially checks the outflow, pours over the sill, and mixes with and oxygenates the salt water in the deep part.

From this consideration of the Norwegian fjords we may infer that, even if the ocean level had not been lowered during the last glacial stage, the Mediterranean, because of the different climate, would have had a surface layer of essentially fresh water overlying the oceanic water that filled the deep basins. Furthermore, the oxygenated Atlantic water would have had free access to the western basin of the Mediterranean through the Straits of Gibraltar beneath the outflowing surface stream of fresh water and in consequence the deep water of the western basin would have continued to be at least partially supplied with oxygen. But with a blanket of essentially fresh water covering the Mediterranean and moving westward there appears to be no way in which significantly large volumes of the oxygen-bearing saline water in the western basin could move across the sill at the Sicily Straits so as to cause circulation and afford an oxygen supply in the deep saline water of the eastern basin. For this reason the water in the eastern deep basin probably would have become stagnant and depleted of oxygen soon after the climatic change permitted fresh water to flood the surface of the Mediterranean.

Now the stagnation engendered in the eastern basin by climatic change alone would have left an unmistakable record in the sediments that accumulated there. Under these conditions the stagnant water becomes poisoned with hydrogen sulfide, which kills off all the bottom fauna. With no bottom dwelling organisms to disturb the sediment and aid in the destruction of the organic matter the sediment accumulates as successive pairs of thin laminae, one of which is rich in

[6] For a full discussion of the Mediterranean hydrography see G. Schott, *Ann. Hydrographie und Maritimen Meteorologie*, 43 Jahrg., Heft 1: 1–18, 1915, and also *Jour. du Conseil*, 3: no. 1, pp. 139–174, 1928.

[7] C. E. P. Brooks, "Climate through the Ages," p. 315, 1926.

[8] E. Antevs, *Amer. Geog. Soc. Research Ser.*, No. 17, pp. 34–39, 1928.

[9] S. Eckman, "Tiergeographie des Meeres," pp. 141–142, 1935.

[10] K. M. Strøm, *Skr. Norske. vidensk. akad.*, Oslo, 1936, No. 7, pp. 7–59.

[11] G. E. Hutchinson, *Trans. Conn. Acad. Arts and Sci.*, 33: 116–127, 1937.

organic matter and represents the annual pulse in the growth of plankton. The other part of the couplet usually consists of mineral particles with less or no organic matter and represents the remainder of the year. In short, varved sediments would have accumulated as they are accumulating to-day in the deep water of the Black Sea,[12] in certain Norwegian fjords,[13] in salt lakes in Crimea,[14] in the lake of Zürich[15] and in the deep, stagnant and lifeless parts of many other lakes and enclosed seas. Thus it appears that the sedimentary record of the eastern basin of the Mediterranean should reflect the marked climatic changes that accompanied the glacial stages of the Pleistocene.

The following consideration of the hydrography of the western basin suggests that its sedimentary record would contain a decisive test of the hypothesis that ocean level was lowered several hundred fathoms during the last glacial epoch. Again the reasoning turns upon analogy with the Norwegian fjords, for, as outlined above, we can assume that the climate alone would have brought about hydrographic conditions in the western basin of the Mediterranean closely analogous with those of certain ventilated or oxygenated fjords discussed by Strøm.[16] If now the level of the ocean were gradually lowered nearly or quite down to the top of the Gibraltar sill the channels across the sills at Gibraltar and the Sicily Straits would be progressively constricted. The eastern basin would be still more effectively sealed, so we need consider it no further. But now the western basin would eventually stagnate and be depleted of oxygen. For some time oxygen-bearing Atlantic water would spill over the Gibraltar sill at high tide or when the wind piled up the water on the ocean side. But when the ocean level reached the level of the Gibraltar sill, 320 meters below present ocean level, or if it sank still lower, then the hydrography of the western basin of the Mediterranean would be like that of the Black Sea to-day. A blanket of essentially fresh water covering the sea, moving westward and overflowing the sill at Gibraltar would seal beneath it the deep body of salt water which, being thus cut off from its supply of oxygen, would become charged with hydrogen sulfide and varves would form in the bottom sediments like those in the eastern basin and like those now forming in the deep, saline, stagnant part of the Black Sea.

Hence it seems to me that organic-rich, non-glacial varves in the deposits of the deep parts of the western basin of the Mediterranean overlain by a considerable thickness (1 to 2 meters?) of limy coccolith and Globigerina ooze would be strong reason for believing that, during the last glacial stage of the Pleistocene, ocean level was lowered about 320 meters or more.

But if sea-level were only lowered 80 or 90 meters during the last glacial stage, as suggested independently by both Antevs[17] and Daly,[18] it seems likely that, although no varves formed, the sediments off the Algerian coast, and perhaps elsewhere along the Mediterranean, should contain legible records of lowered sea level, but the records would be of a different kind. Anderson's[19] interpretation of the Quaternary events along the coast of western Algeria indicate that during the interglacial stages when the sea level rose the valleys slowly filled with generally fine-grained alluvium and that during the glacial stages when the sea level dropped, large volumes of the alluvial deposits were removed from the valleys and carried into the sea. Thus the deposit formed off shore from these streams during the last interglacial stage should be a layer or bed of fine-grained limy mud, rich in pelagic organisms like coccoliths, foraminifera and pteropods —sediments with less clastic material than those forming there to-day. But during that stage when the sea level was falling the sediments formed off this same coast should be distinguishable from those of the interglacial and postglacial stages by their relatively great abundance of clastic material and probably also by different and colder water pelagic organisms.

Because the Mediterranean region is one of volcanic and seismic activity and because the sea itself is rather sensitive to climatic changes the post-Pleistocene history as recorded in the deep water sediments should be unusually legible.

The pelagic fauna of the Mediterranean was presumably quite different at the end of the last glacial stage, by reason of the greater volume of fresh or feebly saline water that flooded its surface. The more or less gradual change from that condition to the present hydrographic condition should be marked in the sediments, especially of the western basin, by the appearance of generally Atlantic types of coccoliths, pteropods and foraminifera which inhabit the surface waters now. Indeed, these forms may have reached a recognizable peak of abundance during the higher sea level of the "climatic optimum."[20] At some level, perhaps corresponding to late Neolithic time, when, according to Sandford and Arkell,[21] northern Egypt

12 A. D. Archanguelsky, *Bull. Soc. Naturalistes du Moscou*, new ser., 35: 264–281, 1927.

13 K. M. Strøm, *op. cit.*

14 B. W. Perfiliev, "Ten Years of Soviet Science," pp. 402–403, Moscow, 1927.

15 Fr. Nipkow, *Rev. d'Hydrologie*, 4 Année, No. 1/2: 71–120, 1927.

16 *Op. cit.*, pp. 42–59.

17 E. Antevs, *Amer. Geog. Soc. Research Ses.*, No. 17, p. 81, 1928.

18 R. A. Daly, *Bull. Geol. Soc. Amer.*, 40: 724–725, 1929.

19 R. v. V. Anderson, *Geol. Soc. Amer., Mem.* 4: 363–376, 1936.

20 C. E. P. Brooks, "Climate through the Ages," pp. 411–414, 1926.

21 K. S. Sandford and W. J. Arkell, "Paleolithic Man and the Nile-Faiyum Divide," Univ. Chicago Press, vol. 1, p. 68, 1929.

became desert, the wind-blown sand from the region south of the Mediterranean should begin to make its appearance. This wind-blown sand is abundant in the sediments forming to-day in the deep basins of the Mediterranean.[22]

Less vague, however, would be the record left by the activity of explosive volcanoes. A considerable number of these ash falls in the upper part of the post-Pleistocene column of sediments should be correlatable with human history. Earthquakes, too, should have caused submarine mud slumps that threw into suspension much sediment which settled as widespread blankets[23] of distinctive sediment. Such a blanket of sediment should show a gradation in grain size due to the differential settling rates of the constituent particles thus thrown temporarily into suspension.

It seems to me, therefore, that long cores of the sediments in the deep basins of the Mediterranean would probably reveal an extraordinarily rich and varied record in a locality critical not only by reason of the unusual configuration of the basin but also by reason of the wealth of information that is already available from the long historic records, the archeology and the Pleistocene and post-Pleistocene geology.

W. H. BRADLEY

TYROSINE DETERMINATIONS[1]

THE author was recently engaged in a study of egg albumin in which it was necessary to run tyrosine determinations on small quantities of the protein. Since the method of Folin and Marenzi[2] requires 100 milligrams for each determination, and that of Lugg,[3] approximately 50 milligrams of protein, it was decided to use Lugg's method. It is for the purpose of discussing modifications of this method that this paper is presented.

In the method under discussion, that of Lugg, the 50 milligram sample of ovalbumin is hydrolyzed in alkali as recommended by Folin and Marenzi, acidified, centrifuged and a 3 ml aliquot diluted to 5 ml with 5 and 1 normal H_2SO_4 in such proportions that the 5 ml solution will be at a pH of 0.3 (from titration of a separate aliquot using brilliant cresyl blue as an indicator). It is common knowledge that no efficient indicator is available at this pH range and that the glass and quinhydrone electrodes are extremely inaccurate for this determination. In search of a simpler method of bringing the pH of the standard and unknown solutions to the same and required value it was discovered that one could very well utilize the normality of the test solutions with respect to H_2SO_4. When the 5 ml test solution is made 1 normal H_2SO_4 the buffer action of the amino acids in the solution and the repression of the ionization of the strong electrolyte (H_2SO_4), results in a pH of approximately 1. Block[4] states that a pH of 2.5 is also satisfactory. A series of analyses using the modification outlined here resulted in the following values for the per cent. tyrosine in egg albumin:

3.77; 3.83; 3.85; 3.81; 3.77; 3.83; 3.84
Mean 3.81

These values are close to the figures reported in the recent literature. Bernhart[5] reports 3.85 per cent. tyrosine in ovalbumin as determined by the method of Folin and Marenzi.

Further study of Lugg's method disclosed that another step could be modified for convenience. After the 5 ml test solution has been mercurated with a mixture of mercuric sulfate and chloride and made up to 25 ml, Lugg recommends that the sodium nitrite be added within an hour and compared colorimetrically with the standard (Millon reaction), since cloudiness may develop on longer standing and hinder the comparison. The following experiment was performed:

Six samples of egg albumin were treated simultaneously and in an entirely analogous manner according to the above discussed modification. After the solutions were made up to 25 ml, four samples were compared immediately, and the remaining two, twenty-four hours later. The results obtained from the two sets, in per cent. tyrosine present, are outlined below (the samples were previously treated in an oven for 24 hours at 110 C.).

	Analyzed immediately	Analyzed 24 hours later
	3.61	3.75
	3.67	3.68
	3.75	
	3.83	
Mean	3.72 per cent.	3.72 per cent.

These data can be interpreted to indicate that the test solution, diluted to 25 ml, can remain at least 24 hours before it is compared colorimetrically with the standard without any appreciable decrease in value of the tyrosine present.

The author wishes to thank Dr. L. Earle Arnow for his kind guidance in the work behind this paper.

CARL REITER

[22] K. Andrée, "Geologie des Meeresbodens," p. 263, 1920.

[23] Fr. Nipkow, *Rev. d'Hydrologie*, 4 Année, No. 1/2: pp. 70–120, 1927.

[1] From the laboratory of Physiological Chemistry, University of Minnesota, Minneapolis.

[2] O. Folin and A. D. Marenzi, *Jour. Biol. Chem.*, 83: 89, 1929.

[3] J. W. H. Lugg, *Biochem. Jour.*, 31: 1422, 1937.

[4] R. J. Block, "The Determination of the Amino Acids," Burgess, Minneapolis, Minnesota, page 21, 1938.

[5] F. Bernhart, Unpublished Ph.D. thesis, University of Minnesota, 1938.

SCIENTIFIC BOOKS

THE THEORY OF FUNCTIONS

Théorie Générale des Fonctionelles. By V. VOLTERRA and J. PÉRÈS. (Collection Borel) Paris, Gauthier-Villars, 1936. xii + 358 pp.

THE volume before us is the first in a series of three, the three together to give a résumé of something over fifty years of the work of Volterra. Although the complementary studies of others are given extensively and a systematic treatment is constructed, thus portraying the whole development of the subject, the exposition would nevertheless demand the attention of mathematicians of this generation, even if it limited itself to the inventions and discoveries of the author himself. Moreover, the author has the good fortune of having as collaborator Professor J. Pérès, who has made many contributions to the subject of functionals and integral equations. This volume and the other two in prospect, as well as the recent treatise, "Opérations infinitésimales linéaires," by Volterra and Hostinsky, form an amplification and modernization of the two volumes on functions of curves and integral equations published in the same Borel series on the theory of functions, some twenty-five years ago.

It is not necessary to detail the entire history of Volterra's contributions to this subject. But it is interesting to recall one or two steps. In the account of the meeting of the Lincei of June 15, 1884, appeared a short note "Sopra un problema di elettrostatica," which deals with the equation,

$$\varphi(x) = \int_o^a f(\alpha)\, F(\alpha, x)\, d\alpha, \quad o < x < a,$$

by means of variational methods. The significance of its result is best expressed in terms of the physical application: Given a conductor which is in the form of a symmetrical portion of a surface of revolution, subject to the action of insulators containing arbitrary charges of electricity provided that these are symmetrical about the axis of revolution, the equilibrium distribution on the conductor can be constructed in terms of the corresponding distribution of unit mass on the conductor when there are no inducing masses present. In 1887 we find these variational principles further developed as the sketch of a general theory of functionals; and also the study of linear differential equations in terms of the infinitesimal analysis of substitutions. In 1894 we have the algebraic theory of integral equations "of Volterra type." A man is indeed fortunate who sows in his youth the seeds of such a harvest.

The first half of the volume is devoted to the general theory of functionals. In this, we have the "passage from the discontinuous to the continuous," the relation to abstract metric spaces with the forms of the linear operator which depend on the various definitions of distance, a development of the calculus of functionals, and its relation to the calculus of variations. The author acknowledges the assistance of Professor Tonelli in this last section. These chapters are not to be taken as a substitute for treatises on metric spaces or calculus of variations, of which there already exist notable instances, but to introduce the reader to the general points of view which envisage them. Rather, there are emphasized the special developments of the theory of functionals itself on the basis of the special properties of one definition of distance, and for the sake of their applications.

The second part of the book deals with integral equations and comprises, as well as the classical theory, various developments in the direction of singular types, equations with multiple integrals, systems of equations and non-linear equations. It is not intended to be as nearly complete a survey as the detailed review of Hellinger in the Encyklopädie, but it is entirely readable and is supplemented by an extensive bibliography. The student will get from it the feeling of pressure outward, rather than the impression of in-breeding that one receives from so many sketches of the topic. One wonders when the subject of the numerical calculation and theoretical location of characteristic values will obtain the systematic development which may be hoped for from a subject as vast as the theory of functions of a complex variable (see for instance Section 35 of Hellinger's above-mentioned report).

There is some development of the "functions of composition," in which the symbolic product fg stands for the expression

$$\int_x^y f(x, \zeta)\, g\,(\zeta, y)\, d\zeta$$

or the corresponding integral with constant limits, the systematic treatment of this subject, with its numerous applications, being left to another volume. Of particular interest are the powers, positive, negative and zero. The power f^o plays somewhat the role of an indicator of an operation to be performed; that is, f^o itself may have no concrete interpretation, whereas $f^o\, g = g$. Whether or not there may be some advantage in separating the roles of unity by introducing a notation analogous to that of quaternions, as the reviewer did at one time, the questions at issue remain fundamentally the same; and the difficulties are in no sense to be obviated by a method of notation.

Altogether the reviewer has no hesitation in recom-

mending the volume to the diligent attention of the student, and looks forward himself to the publication of the later volumes. In particular the reader will find that the treatment serves to give content to those more abstract studies of metric spaces, which indeed have been created in large part out of the fecundity of this topic of functionals.

G. C. Evans

Termite City. By Alfred E. Emerson and Eleanor Fish. With a foreword by William Beebe. Illustrations by Keith Ward. Pp. 127, 37 ills. Rand, McNally and Company, New York, 1937. $1.50.

The inexhaustible store of most interesting natural history pertaining to termites has been tapped in this book by Professor Emerson out of his long accumulated riches of information about this greatly diversified group of social insects. He sets forth in non-technical language the organization of the termite colony; the functions of the several castes; the varied structures found in termite houses; the periodic swarming of the alates; the care of king, queen, eggs, soldiers and larvae; the guest insects found in termite colonies; the destructive activities of cellulose-eating species; and the past history and evolution of the group. A fully annotated glossary adds technical information helpful to the non-specialist reader.

Termites are rather closely related to cockroaches and are thus among the oldest insects known, being found in the carboniferous strata and fully preserved in amber. Although rather simple and generalized in basic structural pattern they are highly evolved in social organization and in structures and instincts related to this mode of life, as shown in the limitation of reproduction to a single pair in the colony, with enormous increase in size and rate of egg-laying in the queen and provision of second and even third form supplementary kings and queens capable of coming quickly into functional activity in the event of the death of either member of the primary pair, or in case of the breaking up of the primary colony by isolation of outlying extensions or transportation of a fragment of the colony to a new site. Other specializations are found in the soldier caste, which also may have second and third forms in the same species. Some of these develop powerful mandibles, while others are nasute types with glands exuding a sticky fluid for entangling enemies or a poison gas for destroying them. As in the case of the military forms among other social animals the soldiers sacrifice themselves for the good of the group, are unproductive and are faithfully fed by the workers; the latter in the more highly evolved termite families form a slave caste deprived of flight and the reproductive function.

More specialized still are the complicated instincts of each caste by which the social organization is conserved. As noted by Darwin in his discussion of the difficulties attendant upon his theory of natural selection, these extraordinary instincts are exhibited by individuals who leave no offspring, and their parents never exhibit these same instinctive behaviors. This may be a highly specialized form of recessiveness of characters linked with the capacity for normal sexual activity.

Professor Emerson brings out of his closet of termite skeletons some of the disjunct members which haunt a student of these perplexing activities in the termite colony. Most of the work of the colony is done by individuals which are blind. Their antennae and mouth parts have a variety of sense organs adapted by structure as tactile and chemical receptors, but auditory organs are lacking and visual ones occur only in a rudimentary state even in the alate phase. How then is coordinated activity established and maintained? How do the blind soldiers find their way to guard the portal of exit, space themselves in order according to rank about the queen, or along the line of march? How do workers without blue prints or supervising architect build earthen towers with a ventilating system, oriented to the points of the compass, or erect rain gutters on the trunk of a tree to shed water from the nest starting these structures at the top and bottom of the series and meeting in good form at the middle? Verily instinct covers a multitude of unsolved problems in the termite world.

Termites also give rise to another set of problems among termitophiles which live in their colonies, which as beetles of strange pattern and stranger behavior, with abdomens reflexed over their back with segmental spigots flowing with milk and honey for their hosts. The fact that termitophile insects come to smell like their hosts may explain their toleration by their otherwise cautious hosts, but their structural changes might perplex even an enthusiastic biochemist.

Termites destroy man's utilized cellulose, preempt his fertile lands in the tropics by massive earthen structures, often sheltering fungus gardens. These are so durable that the recovery of the land for agriculture is unprofitable, though the termite mortar is good road metal. Termites also reduce forest waste, rapidly returning fallen trees to the soil, thus building up humus. They also facilitate erosion and help in building up alluvium and sedimentary deposits. The volumetric aspect of their relation to nature and man is based upon their social activities. The termite colony, given favorable conditions within reach of their exploratory habits, is practically immortal. It is fascism without a Hitler imposing its Kultur upon every individual and ever demanding room for more colonies.

Charles A. Kofoid

SPECIAL ARTICLES

VOCAL PITCH DURING SIMULATED EMOTION

THE present report is limited to consideration of the pitch of the voice during simulated emotion. It differs from previous studies in two respects: (1) Identical reading materials were used in simulations of all emotions studied; (2) the effectiveness of the simulations was measured.

The test passage, "There is no other answer. You've asked me that question a thousand times, and my reply has always been the same. It always will be the same," was read by six competent amateur male actors to portray each of the following emotional states: Contempt, anger, fear, grief and indifference. Phonograph records of the readings were cut. The recordings were played before a group of 64 observers, in whose hands had been placed lists of twelve emotional states, among which appeared the five being studied, as follows: Amusement, anger, astonishment, contempt, doubt, elation, embarrassment, fear, grief, indifference, jealousy, love. The observers were asked to select from the list the term which named most accurately the emotion being simulated as each recording was played. A random order of presentation was used. From these judgments it was possible to rate the portrayals in terms of the percentage of the observers able to identify them.

Measurements of the fundamental sound wave frequencies employed were made from the phonograph recordings by phono-photographic techniques. The results of the analysis are presented in Table I. It will be understood that the measure listed as median

TABLE I

AVERAGE MEASURES OF PITCH

	Contempt	Anger	Fear	Grief	Indifference
Percentage of correct judgments	84	78	66	78	88
Median pitch level [cycles per second] ...	124.3	228.8	254.4	135.9	108.3
Nearest musical tone..	B_1	$A_2^\sharp$	C_3	$C_3^\sharp$	A_1
Total pitch range [tones]	10.5	10.3	11.2	9.0	7.8
Mean inflectional range [tones]	2.2	2.6	2.3	1.7	2.0
Rate of pitch change [tones per second].	16.8	25.6	19.0	15.6	16.6

pitch level in this table is the median fundamental frequency employed. It is referred to as "pitch level" to distinguish it from the concept of frequency level in octaves above 16.35 c.p.s., and because it is a term in common use among students of speech. The nearest musical tone is that on a musical scale where A = 440 c.p.s. Measures of range were computed by means of the relation $N_{Tones} = 19.92 \log_{10} \frac{f_1}{f_0}$, where f_1 is the higher and f_0 the lower frequency.

That the simulations studied were characteristic of the emotional states is readily observed from the high percentage of correct identifications, as seen in Table I. Further reference to this table and to Fig. 1 shows that striking differences obtain between the median pitch levels measured for the different emotions. It will be observed that indifference employs a lower pitch level than any of the other readings and that each emotion appears to have a characteristic comparative pitch level different from other portrayals. A significant

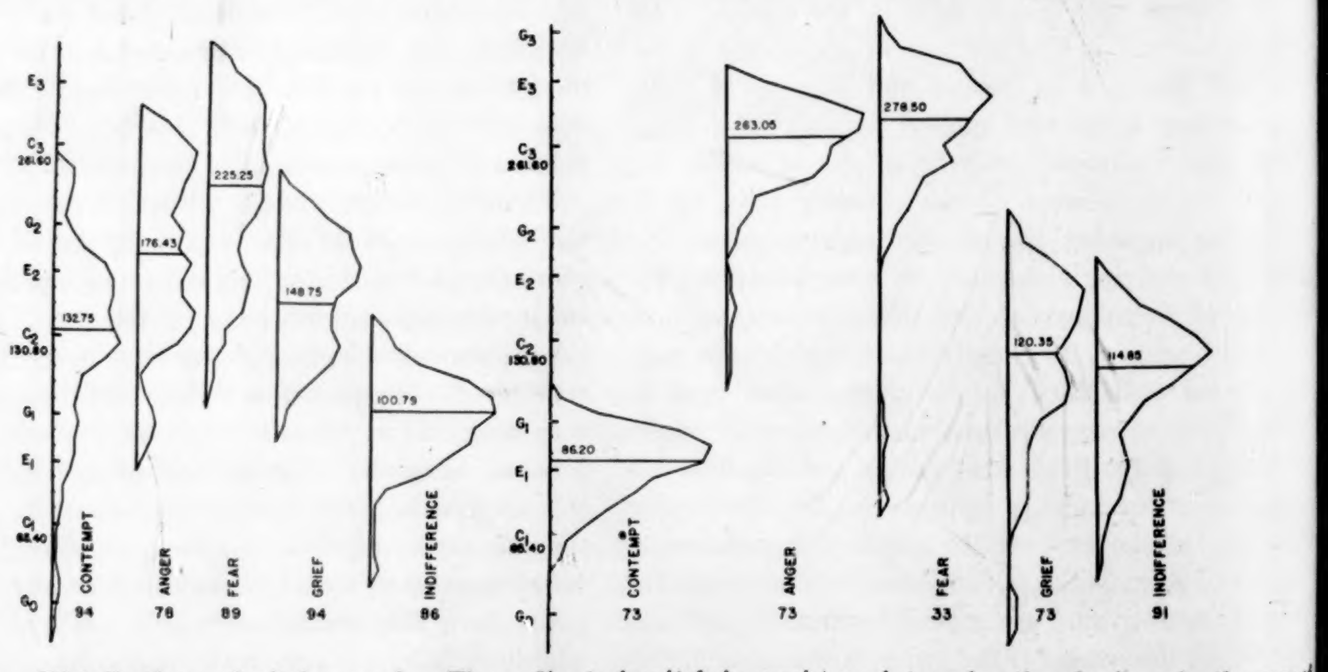

FIG. 1. Distributions of pitches used. The ordinate is pitch in semi-tone intervals; the abscissa, in the case of each distribution, is percentage of cases. Left, effective actor; right, ineffective actor. Medians indicated by horizontal lines across each distribution and labeled in cycles per second. Lower numbers show percentage of observers making correct identification.

fact is that pitch levels for indifference, contempt and grief are in the neighborhood of C_2, while those for anger and fear are approximately one octave higher at C_3.

Indifference employs the narrowest total pitch range, about an octave, with grief using a range of one and one half octaves, and contempt, anger and fear approximately two octaves. The distribution of pitches used within these ranges is observed from the graphs of the effective readings in Fig. 1 to approximate a normal distribution.

The mean extent of inflections (*i.e.*, frequency modulations either upward or downward) is seen to vary from one third to approximately one half an octave in extent. Grief employs the narrowest inflectional range and anger the widest, with the other emotions falling within the interval which separates these extremes.

An additional means of distinction between emotions is afforded by a measure of the rapidity with which pitch changes per unit of time during inflections. An expression of the rate of this change is given in tones per second by dividing the pitch range in tones of a given inflection by its duration in seconds. As with inflectional range, anger and grief are the extremes, with anger using the fastest rate of pitch change and grief the slowest, the difference being ten tones per second. The speed of pitch change for contempt and indifference is slightly more rapid than for grief, while fear exceeds this value by approximately two tones per second.

Fig. 1 presents distributions of the pitches used by typical effective and ineffective actors. It is interesting to note that the ineffective actor deviates markedly from the effective performer in all but indifference, in which both were judged as being highly effective. Examination of the figure shows that pitch levels for the poor readings are not defined as clearly as those for the better readings. The median pitch levels in anger and fear are almost identical, as are those in grief and indifference, while contempt, contrary to the effective as well as average measures, employs a pitch level which is considerably lower than other attempts by this actor. The latter's simulation of contempt uses also an extremely narrow pitch range of less than one octave, and the extremely wide ranges of his fear and grief are due to the presence of a few very low pitches. The above deviations represent the typical differences between effective and ineffective portrayals. It is probable that the ineffectiveness is the result, to some degree at least, of these extreme deviations from the average and effective simulations.

One striking result regarding pitch in emotional speech was obtained by computation of the total pitch range employed by each actor in portraying all five emotions. It was found that five of the six actors used a total pitch range of over three octaves.

From the above data it is possible to characterize each emotion comparatively on the basis of pitch usage alone, as follows:

(1) Contempt. (a) Low median pitch level (124.3 c.p.s.), but (b) wide total pitch range (10.5 tones).

(2) Anger. (a) High median pitch level (228.8 c.p.s.), (b) wide total pitch range (10.3 tones), (c) widest mean inflectional range (2.6 tones), (d) most rapid pitch change (25.6 tones per second).

(3) Fear. (a) Highest median pitch level (254.4 c.p.s.), (b) widest total pitch range (11.2 tones).

(4) Grief. (a) Low median pitch level (135.9 c.p.s.), (b) narrow total pitch range (9.0 tones), (c) narrowest mean inflectional range (1.7 tones), (d) slowest pitch change (15.6 tones per second).

(5) Indifference. (a) Lowest median pitch level (108.3 c.p.s.), (b) narrowest total pitch range (7.8 tones).

GRANT FAIRBANKS
WILBERT PRONOVOST
STATE UNIVERSITY OF IOWA

PHOSPHORUS METABOLISM OF CHICKS AFFLICTED WITH PEROSIS

PEROSIS (slipped tendon) in chicks was first described by Hunter and Funk.[1] It has been studied by a number of investigators, and recently Wilgus, Norris and Heuser[2] have shown that the affliction can be corrected by raising the level of manganese in the ration. This observation has been confirmed by a number of investigators.[3]

The disorder is characterized by a bowing of the legs in the tibia—metatarsal joint, enlargement with a tendency toward flattening of the joint and finally slipping of the Achilles tendon from its normal position. Perosis has been produced by the feeding of high levels of calcium phosphate—3 to 5 per cent. of the ration. Our ration[4] for producing this condition is given in Table 1.

The addition of 50 mg of manganese as $MnSO_4 \cdot 4H_2O$ per kilo of the above rations protects the chicks from perosis. Injection of 1, 3, 10 or 50 mg of manganese per week, in two equal doses, also protects on ration 604. No data involving injection are as yet available with ration 610. Rice bran fed at the level of 15 or 20 per cent. protected on ration 604. Auto-

[1] J. E. Hunter and E. M. Funk. *Proceedings* of the 22nd annual meeting of the Poultry Science Association, Macdonald College, Quebec, p. 45, 1930.

[2] H. S. Wilgus, Jr., L. C. Norris and G. F. Heuser. SCIENCE, 84: 252, 1936; *Jour. Nutrition*, 14: 155, 1937.

[3] V. G. Heller and R. Penquite, *Poultry Science*, 16: 243, 1937. M. Lyons, W. M. Insko, Jr., and J. H. Martin, *Poultry Science*, 17: 12, 1937. M. Lyons and W. M. Insko, Jr., *Ky. Agr. Exp. Station Bull.*, 371, 1937. P. J. Schaible, S. L. Bandemer and J. A. Davidson, *Poultry Science*, 16: 367, 1937.

[4] L. E. Clifcorn, C. A. Elvehjem and E. B. Hart, *Poultry Science*, 17: 28, 1938.

TABLE 1

	Ration 604	Ration 610
(Dried beef kidney 15)		
(Dextrin .... 48)	71	69
Crude casein	14	14
Brewer's yeast	2	2
Salts I	5	5
$Ca_3(PO_4)_2$	3	5
Alcoholic extract rice bran ..	5	5
Percomorph oil—3 drops twice weekly		

claved rice bran failed to protect. The ash of rice bran or the manganese equivalent to that of 15 or 20 per cent. of rice bran also failed to protect when fed with ration 604.

These observations led to an investigation of the phosphorus distribution in the blood of normal and perosis birds as well as the phosphatase content of the blood and bone. It was found that the inorganic phosphorus of the blood remained constant in both normal and slipped tendon birds and at a level of approximately 4.7–5.6 mg per 100 cc of blood. The ester phosphorus was approximately 26–30 mg per 100 cc of blood in the case of perosis, while the total phosphorus ranged from 100 to 141 mg per 100 cc of blood. In normal birds produced by feeding or injecting manganese, the ester phosphorus ranged from 32–44 mg per 100 cc of blood, while the total phosphorus varied from 100–132 mg per 100 cc of blood. The most characteristic feature of the phosphorus distribution in the normal and afflicted birds was a higher ester phosphate in the blood of the normal birds.

In respect to the phosphatase content of bone and blood of normal and slipped tendon birds, there was also a clear-cut difference. On ration 604—which produced 100 per cent. slipped tendon—the phosphatase content of the blood ranged from 2.1–3.1 units per 100 cc of blood and from 3.6–7.7 units per gram of green bone. In the birds protected by manganese feeding or injection at different levels, the phosphatase content of the blood varied from 15.9–51.3 units per 100 cc of blood and from 8.5–10 units per gram of green bone. It is apparent that in the complex process of normal bone formation, a high inorganic calcium phosphate ingestion had depressed the phosphatase content of blood and bone, and at the same time there had occurred a lowering in the ester phosphate level of the blood.

It is possible that the autoclaving of rice bran, which is then rendered ineffective as a protective agent, is linked with a destruction of the phosphatases of the bran. Since rice bran is rich in phytin—the calcium-magnesium salt of phytic acid—we raised the question as to whether there was a possibility that inositol (a constituent of phytic acid) might be concerned in the ester phosphate increase observed in normal birds as compared with those afflicted with slipped tendon. Feeding inositol on ration 604 at a level of 5 grams per kilo did not protect against perosis. Injection of inositol at the rate of 50 mg per week did not protect with ration 604. However, we have observed that with ration 610—containing 5 per cent. of calcium phosphate—and supplemented with 20 mg of manganese per kilo, there is no protection against perosis. The manganese level is not high enough. The ester phosphorus remains below 30 mg per 100 cc of blood and the phosphatase at 30 units per 100 cc of blood and 6.4 units per gram of green bone. When the chicks receiving ration 610 supplemented with 20 mg of manganese per kilo were injected with 100 mg of inositol per week, there was complete protection against perosis. The ester phosphorus rose to 34 mg per 100 cc of blood and the phosphatases of the blood to 40.5 units per 100 cc. With the same ration injection of 10 mg of inositol or of 100 mg of glucose per week did not protect. We hesitate at this time to state definitely that the increase in ester phosphorus of the blood by injection of adequate manganese or inadequate manganese plus inositol resulted in the formation of inositol esters of phosphoric acid, but such a possibility may well exist. So far as we know, no one has isolated from animal tissue phosphoric esters of inositol, although they are known to exist abundantly in the seeds of certain plants. Free inositol itself is known to occur in muscle and brain; however, its function has not been disclosed.

A. C. Wiese
B. C. Johnson
C. A. Elvehjem
E. B. Hart

College of Agriculture,
University of Wisconsin

THE GROWTH OF LEPTOSPIRA ICTEROHEMORRHAGIAE ON THE CHORIO-ALLANTOIC MEMBRANE OF THE CHICK EMBRYO

A wide variety of bacteria and viruses has been successfully grown in the tissues of the chorio-allantoic membrane of the chick embryo by a number of workers.[1] Up to the present time, however, no one has described the cultivation by this method of any member of the family *Spirochetales*. The purpose of the present note is to report the use of chorio-allantois of the chick embryo for the successful cultivation of *Leptospira icterohemorrhagiae,* the causative organism of Weil's disease (infectious spirochetal jaundice or *spirochetosis icterohemorrhagica*).

The strain of *Leptospira icterohemorrhagiae* employed was isolated at autopsy from the kidney of a man who died of Weil's disease at Rochester, N. Y., on February 19, 1937. The strain was maintained by passage in guinea pigs and by cultivation in Fletcher's

[1] See reviews by F. M. Burnett, *Med. Res. Council, Sp. Rept. Series,* No. 220, 1936; also, E. W. Goodpasture, *Amer. Jour. Hyg.,* 28: 111, 1938.

medium.[2] On May 5, 1938, 0.1 cc of a positive culture was inoculated on the chorio-allantoic membrane of each of 10 eggs, incubated for 10 days, according to the method of Goodpasture and Buddingh.[3] Transfers were made every 4 or 5 days. To effect a transfer, 2 or 3 membranes were triturated in a mortar with Alundum and Locke's solution to make a 10 per cent. suspension. For the inoculation of each egg, 0.1 cc of this preparation was dropped on the presenting ectodermal surface of the chorio-allantois.

The spirochetal organisms were carried through 20 successive passages in the developing egg. After each fifth passage, 1 cc of the "transfer inoculum"—the 10 per cent. suspension of triturated infected membranes —was injected subcutaneously into each of 2 guinea pigs. In every instance, the inoculated guinea pig developed fever within 4 or 5 days and became jaundiced. The infection was uniformly fatal in from 6 to 8 days. At autopsy, the characteristic findings of experimental Weil's disease in guinea pigs were encountered. Jaundice of the skin, jaundice and hemorrhages in the subcutaneous and cartilaginous tissues and hemorrhages in the lungs and abdominal viscera were typical.

The organisms were seen by the darkfield technic in centrifugalized "transfer inoculum" and in the amniotic fluid.

After inoculation on the chorio-allantois, the organisms regularly invaded the embryo. The resulting generalized infection killed the embryos in 6 or 7 days. The organisms have been recovered from the blood of the embryos and from various tissues by the inoculation of these materials into guinea pigs. It has been found that 0.15 cc of blood from the allantoic artery contain sufficient spirochetes to kill guinea pigs within the usual period.

Grossly, the membranes showed scattered, grayish, opaque, pin-point nodules. Microscopically, the nodules were seen to be the result of a localized proliferation of ectodermal cells, and of edema, proliferation of the fibroblasts and infiltration of a few inflammatory cells in the mesoderm. Sections of infected chorio-allantoic membranes and embryos, stained according to the silver impregnation technic of Levaditi, revealed the presence of *Leptospira icterohemorrhagiae* in both the membranes and embryos.

In summary, it has been shown that *Leptospira icterohemorrhagiae* can be successfully cultivated in the chorio-allantoic membrane of the chick embryo. The organisms produced a generalized and fatal infection in the developing chick. After 20 serial passages in the embryonic tissues, the pathogenicity of the spirochetes for guinea pigs was unaltered. Indeed, virulence may have been enhanced. An attempt is being made to grow other members of the family *Spirochetales* by this method.

Grant Morrow
Jerome T. Syverton
William W. Stiles
George Packer Berry
School of Medicine and Dentistry,
University of Rochester

[2] W. Fletcher, *Trans. Roy. Soc. Trop. Med.*, 21: 265, 1928.

[3] E. W. Goodpasture and G. J. Buddingh, *Amer. Jour. Hyg.*, 21: 319, 1935.

SCIENTIFIC APPARATUS AND LABORATORY METHODS

AN IMPROVED APPARATUS FOR THE SERIAL SECTIONING OF FOSSILS

In 1933 Simpson (*Amer. Mus. Nov.* No. 634) described a very simple method of producing serial sections of fossils to which the reader is referred for the actual technique. Without claiming to introduce something essentially new it is suggested that the apparatus then described is capable of certain improvements, making it less delicate to handle, and at the same time increasing its accuracy. The number of components is even smaller, and the actual execution is still within the scope of any mechanic provided with an ordinary instrument-maker's lathe. The overall length of the new design is greater than that of the original construction, which may even be an advantage affording a better grip. This greater length is due to the holder being extended to carry a millimeter scale above the threaded portion, the pitch of the thread being one mm. The sleeve on its conical upper end is divided into 100 parts, the two scales together forming a micrometer reading to 0.01 mm. This arrangement prevents the locknut being placed above the sleeve. Instead it has been placed inside the latter and is made in one piece with the guide. Its lower edge stands 0.5 mm behind the lower edge of the sleeve. A suitable spanner with two studs fitting the two holes in the lower rim of the guide (locknut) is used for tightening it. If a right-hand thread is used the scales should read in the direction given in the diagram.

The advantages claimed are the following: absence of the delicate pointer, which is easily bent; the threads are covered and thus protected from injury; the scale is an integral part of the sleeve, doing away with the sticking on of a paper-scale; mistakes in taking the readings are less to be feared.

In order to reduce wear of the lower edge of the sleeve a ring could be shrunk on to it, either of hardened steel, or better still, of one of the modern cutting metals like Stellite, Acrite, etc. In this case it might be necessary to use kerosene oil instead of water for

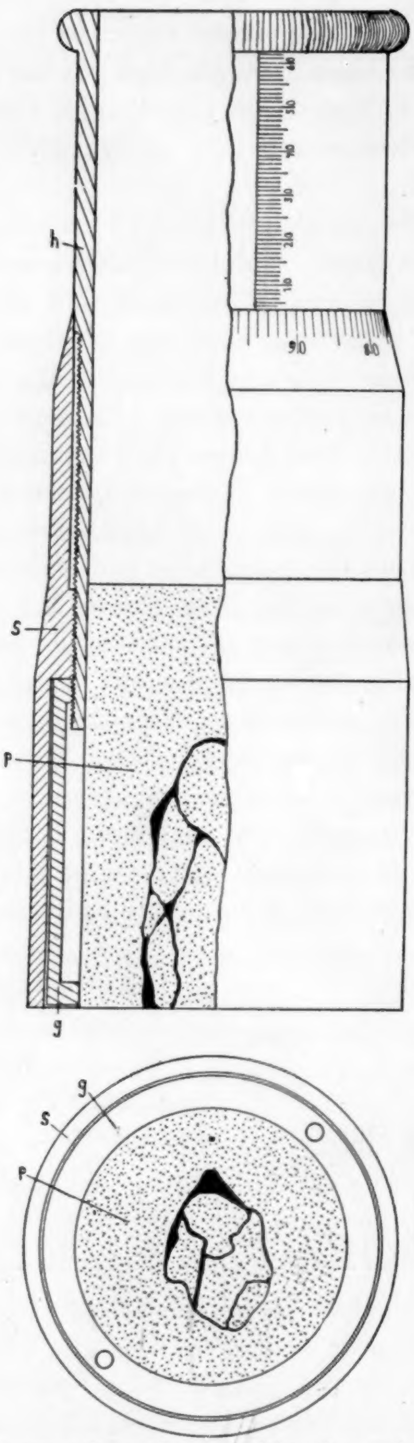

FIG. 1. Improved specimen holder for grinding serial sections. The upper figure represents, to the right, a lateral external view of the apparatus, and, to the left, a longitudinal section. The lower figure represents an end view. Both show a plaster block, with embedded specimen, in place at a stage when a section has just been completed. About one half natural size. g, guide for the plaster block, also serving as set-screw. h, holder. p, plaster block with specimen. s, sleeve.

the cleaning of grinding stone and specimen in order to prevent rust.

OTTO ZDANSKY

A MICRO-CONDUCTIVITY CELL OF SIMPLE DESIGN[1]

IN some recent studies of the rate of elimination of materials by the excretory system of insects, we have made use of the change in electrolytic conductivity of the physiological salt solution bathing the malpighian tubules as an indicator of change in overall salt concentration.

Since the volume of liquid was only about 20λ, it was necessary to use a conductivity cell of 10λ volume or less. While several micro-conductivity cells have been described,[2] they are not easily constructed, and they do not have the advantages of the pipette type in ease of filling and cleaning. Fig. 1 shows the complete cell, right, and a detail of the electrodes, left. For construction, pyrex capillary tubing of about 0.7 mm bore was broken cleanly and one of the cylindrical platinum electrodes with the lead attached was inserted and shaped to fill the tube, using a finely drawn glass rod as a tool. The two pieces of capillary were then reunited in a soft oxygen flame, taking care that the platinum cylinder completely filled the bore of the tube. The tube was then broken again at a second point and the second electrode was inserted in the same manner. Finally, the tip and safety bulb were formed, and the electrodes were ready for platinizing.

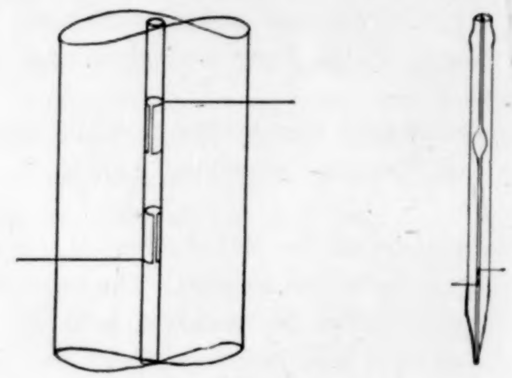

FIG. 1

A cell, as described, will have a resistance of about 2,000 ohms when filled with 1 per cent. NaCl solution. The cell resistance is accurate to 0.1 per cent. at constant temperature.

RODERICK CRAIG
ROBERT L. PATTON

[1] From the laboratories of insect physiology and toxicology, Division of Entomology and Parasitology, University of California, Berkeley, California.

[2] See, for example, H. L. White, *Jour. Biol. Chem.*, 99: 445, 1933.

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